SCIENCE

11 October 1957

Volume 126, Number 3276

ERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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1

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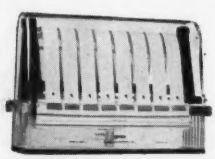

2

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Beckman / **Spinco Division**

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The Invisible Word, or No Thresholds Barred

As Vance Packard tells us in his recent book, *The Hidden Persuaders*, advertisers are currently paying a good deal of attention to motivational research. The aim of such research is to find out what motives lead people to purchase one product rather than another.

If motivational research shows that what people really want is a car that is recognizably this year's model, then designers can plan a car that is distinctively different from last year's. Cigarette manufacturers have a more difficult problem. The onlooker can't tell whether someone is smoking a king-size *Whosis* or a king-size *Whatsis*. One approach is for the advertiser to convey the idea that the right kind of people smoke the brand they are pushing. Thus one brand may go after the outdoor type by showing a contented cowpoke flipping the lid of a box of their cigarettes, while the other appeals to the romantic type by showing a couple of happy-looking, clear-eyed youngsters heartily inhaling theirs. Of course, one or the other may try to capture both types by showing a couple of happy-looking, clear-eyed youngsters pausing for a puff at timber line.

This has its disadvantages: the advertising has to be fairly elaborate, motivational research may go astray, and some mental activity on the part of the customer is required for him to get the point. How much simpler it would be if all conscious activity could be bypassed entirely! If ready-made motives could be fed into the region of the brain where motives are generated, the potential customer would not even have to make the mental effort required to identify himself with the fortunate alpinist at timber line.

The day for this may be at hand. Psychologists have known for some time that messages may be conveyed to a person without his being aware of the fact. This can be done by showing a message at such an intensity that it is just below the threshold for conscious awareness; a word flashed momentarily on a lighted screen will serve. Two companies have recently perfected devices that will project words at subthreshold intensities on a movie or television screen while a show is in progress. One company claims to have increased the sale of popcorn by flashing appropriate invisible messages to an unwitting movie audience, and another found that people could solve anagrams more rapidly if they had been exposed in advance to invisible solutions.

Editorial comment about the use of these devices has varied: the *New Yorker* reacted mildly, the *Saturday Review* vigorously. The *Review* was especially fearful about the prospective invasion of the mind's privacy and the possibilities that presidential candidates might be marketed like popcorn.

We don't take the invisible word so seriously: technical control of its use offers no great difficulties, and it may even be that the advertisers themselves will shy away from its use in time. According to the results of one company, the reaction to the invisible word is affected by the content of the accompanying show: if the word accompanies a movie people like, they favor the word; if it accompanies a movie to which they are neutral or hostile, they reject it.

This paves the way for an interesting variation in advertising technique. Suppose the manufacturers of car A want to reduce the sales of car B. They would flash the name of car B on the screen when a Bad Guy was in action; the makers of car B would retaliate. The sales of both would drop and before long nobody would buy either car—unless he happened to like Bad Guys.—G. DuS.

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In Pursuit of a Gene

Bentley Glass

The pursuit of a wild animal begins with tracking the spoor. In the case of certain wild animals which have never been seen, such as the Abominable Snowman and the Gene, this is as far as anyone has ever gotten—in the Himalayas, tracks in the snow, probably grossly enlarged and deformed in shape by melting and evaporation; in the phenotype, traces of hereditary effects altered and confused by penetrance and pleiotropy, polygenic modifiers and major suppressors or enhancers, thresholds, temperature and other environmental factors, and, of course, sex. Yet here we perforce begin—with the somatic trail left behind as the gene slithers from one generation to the next, through the secret paths of the germ plasm.

In these days of the operational definition, we should quite properly not be speaking of "genes" at all, but of units of mutation, recombination, or function —to use Benzer's colorful terminology, of "mutons," "recons," and "cistrons," respectively (*1*). Nevertheless, it is my conviction that in ordinary scientific conversation the term *gene* will continue to be used for these several units, since they are after all not altogether independent. The trail we pick up and trace through its effects upon the phenotypes of our animals (or other organisms) is detectable because of alterations in the *functions* of hereditary units which originate through mutation and are localizable in the chromosomes through the analysis of recombination. Just as the term *enzyme* remains convenient and meaningful despite the fact that the supposedly unitary enzyme has broken up into composites of apoenzyme, coenzyme, and chelated metal ions, with enzyme function and specificity depending on the exposure and configuration of one or more "sites" which can vary independently of one another, so the concept of the gene will remain useful despite its compound complexities and its nebulosity at each end where it melts into the genetic continuum of the chromosome.

In following the trail we must of course be canny and not dash off like any unseasoned hound on the first fresh cross trail. There are many genes, and there are many trails not made by genes at all. Note therefore that my title is "In pursuit of *a* gene," not "In pursuit of *the* gene." Some 15 years of tracking one particular gene in that relatively well known countryside delimited as *Drosophila melanogaster* have afforded me a certain amount of insight into the habits of the elusive quarry I have been pursuing. I cannot claim even to have glimpsed it, as yet; but I can testify that the assiduous pursuit of such game has many surprises, and what I have learned about the habits of the quarry is possibly of more general significance than what I might have turned up had I followed every fascinating fresh scent into the underbrush. At any rate, certain major problems have been illuminated to some extent in my own mind, and it is to these that I wish to confine my remarks.

One problem is the question regarding the time during life when genes act, and the modus of obtaining a clear-cut answer to the question. A second problem is that of the nature of gene action, and particularly of the action of suppressor genes that produce (or restore) the normal phenotype by a different mechanism or channel from that utilized by the normal allele of the mutant which is suppressed. I am quite convinced that the further analysis of the action of suppressor genes will afford us more insight into the nature of gene action than the analysis of almost any other genetic type of interaction. Third, I shall come to an evolutionary consideration of paramount significance: What is the meaning of the widespread distribution in natural populations, within single species and within related species, of diverse genetic means of attaining the same end, the production of a particular "normal" phenotype?

The Time of Gene Action

Fifteen years ago I had occasion to x-ray the eggs of two different strains of *Drosophila melanogaster* with the moderate dose (for *Drosophila*) of 1000 roentgens (*2*). Nothing very remarkable was noted when the treated individuals of one strain emerged as adults, but all or nearly all of the individuals of the other strain emerged with grotesque growths in the center of each eye (Fig. 1). As fully grown larvae, the individuals of this second strain also contained numerous free melanotic tumors in the body cavity, or hemocoele (Fig. 2). After a preliminary flurry of excitement over the thought that perhaps directed mutation had been achieved, it turned out that when these treated individuals with erupt eyes and melanotic tumors were mated among themselves, their offspring lacked tumors and had perfectly normal eyes.

The induced effects were therefore not hereditary—or so it seemed until crosses were made between untreated individuals of the strain that responded to the x-rays and the strain that did not. It was then found that, by retaining the third pair of chromosomes but replacing the second pair of the responding strain by those from the other, one could extract a stock that, without any treatment at all, consisted of flies with full-blown eye growths. Conversely, by replacing the third chromosome pair of the responding strain with those derived from the other, while keeping the second chromosome pair, a stock was obtained in which every larva develops melanotic tumors. The original responding strain was thus shown to carry two mutants, one for each of the two types of abnormal growth described and, at the same time, two specific suppressor genes that usually inhibit the manifestation of the presence

The author is professor of biology at Johns Hopkins University, Baltimore, Md. This article was his vice-presidential address given before Section F–Zoological Sciences at the 1956 New York meeting of the AAAS.

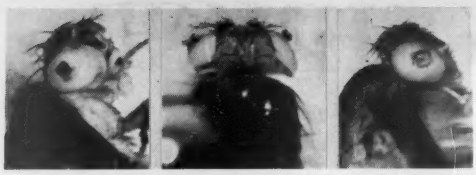

Fig. 1. Erupt-eyed *Drosophila melanogaster*. Expression extreme. Eye color, brown-scarlet, phenotype nearly white.

of the mutants but fail to do so when the eggs are x-rayed. The arrangement of the mutants and their suppressors is a reciprocal one (Fig. 3). The strain is hereafter referred to as the "double-suppressor" strain.

As a means of determining when the suppressor genes act during development, not only eggs but also larvae of various ages were treated with a dose of 1000 roentgens (*3*). This investigation has been completed only with respect to the suppressor of erupt, and further discussion of the time of action of these genes is limited to the erupt-suppressor-erupt system. Interpretation was greatly simplified by the fact that, no matter what the time of treatment with x-rays, no recovery occurred thereafter. Treatment was effective until the period when the eye of the fly actually begins to differentiate, during the third larval instar.

The effect of the x-rays, in other words, was of an all-or-none type during the embryonic period and the first larval instar, and it began to diminish only in the middle part of the second larval instar (Fig. 4). X-rays applied late in the third instar were without effect on the suppressor-erupt system. When an effort was made to push back the time of treatment to as early a moment as possible during cleavage, H. L. Plaine and I were eventually able to collect and irradiate a sufficient number of eggs within 16 minutes after their fertilization and deposition. Inasmuch as meiosis in *Drosophila* is blocked in Metaphase I, and completion of the meiotic division occurs only after fertilization, it follows that in these 8 ± 8-minute-old eggs the sperm and egg pronuclei had not yet united and cleavage had not yet begun when the x-ray treatment was administered. Nevertheless, full inhibition of the suppression of erupt by the x-rays was observed, as usual.

However, when unfertilized eggs or spermatozoa, or both, were irradiated, even with a dose of x-rays 4 times as high, no interference with the suppression of erupt could be observed at all. It is therefore evident that the x-rays effectively destroy some hypersensitive substance or system related to the suppression of the erupt phenotype, and that this sensitive reacting system comes into existence upon fertilization and is not replenished during the remainder of the life-cycle but remains unutilized until the third instar, when, at the time of the differentiation of the eye, it is gradually depleted.

Is the sensitive substance (or system) then to be identified as the primary product of the gene, or is it on the contrary an essential substrate or precursor for the gene's action? If the first is the case, then clearly the gene we are studying may exert its primary action enormously in advance of any visible differentiation affected by it and in advance of such critical periods (temperature-sensitive period, chemical-sensitive period) as have been regarded by many gene physiologists as indicating something about the time of gene action. But if the sensitive substance is substrate, rather than primary product, the action of the suppressor gene might actually be concurrent with differentiation of the eye. To distinguish between these alternatives is not easy.

In current biochemical genetic theory, the gene is conceived as determining the specificity of some single enzyme. Thus, in the classic case of the eye-color mutant vermilion in *Drosophila,* the conversion of tryptophan to kynurenine is blocked, presumably through a failure in the production of one of the enzymes required in this three-step process. As a consequence, no brown eye-color pigment is produced. But the formation of kynurenine, as is shown by the classic studies of Beadle, Ephrussi, Tatum, and others, does not take place in the eye at all but in the gonads and other organs, whence it diffuses into the eye discs. The time of gene action in that instance is not at all at the time of pigment differentiation but at some time prior to, or during, the formation of the enzyme concerned. A preliminary investigation in our laboratory by Frank Erk (*4*) has indicated the presence of kynurenine even in the *Drosophila* embryo. This early-formed kynurenine may never be available for the formation of eye pigment in the pupa. It may be destroyed long before the development of the eye makes utilization of the kynurenine possible.

Thus the enzyme may be present and active long before the conditions for the utilization of its product are fulfilled. Or, the enzyme may be present but its substrate inaccessible to it, as is apparently true in some portion of the intervening period, when kynurenine is not to be found. The question we have posed thus becomes the following: When do the genes determine the specificity of the enzymes they control? Is it even incredible to suppose that all the enzymes are made at, or shortly after, fertilization but, like the inducible enzymes of microorganisms, become abundant and enter into activity only when supplied with substrate?

To approach the question from another angle, we might consider the action of the genes in the case of "autonomous" characters in organisms possessing a mosaic type of development, such as *Drosophila.* As Stern (*5*) and others have shown, a somatic mutation or segregation of a gene affecting body or eye color or bristle growth may produce a very small area—even a single cell—characterized by the mutant phenotype. Is this not proof of the late action of the genes concerned? What it actually shows, it seems to me, is merely that a *change* in genetic constitution can bring about a *change* in phenotype even at so late a period in development. To wit: the enzyme concerned may be maintained in the cell only through the continual ministration of the controlling gene. As in the so-called "abortive transductions" in *Salmonella* and other bacteria (*6*) or in the maintenance of kappa in *Paramecium* (*7*), if the gene is removed or changed, the enzyme (or other gene product) disappears or is fundamentally

Fig. 2. Larvae of the tumorous nonsuppressor-tumor strain, with one to numerous melanotic tumors of various sizes in each.

altered. But the reaction governed by the enzyme may well have been occurring from the beginning, and the action of the gene have been continuous. Thus neither the diffusible nor the nondiffusible products of gene-controlled reactions really tell us when the gene is acting.

If, however—to return to the suppressor-erupt system—the x-ray-sensitive substance is not the primary product of the reaction controlled by the gene but is, instead, an essential substrate or precursor, it might be possible to answer the question by injecting body fluid or extracts from the nonreacting strains (*su-er*$^+$) into irradiated recipients of the reacting strain—namely, suppressor-erupt individuals in which the suppression of erupt had been blocked by destruction of the precursor but in which the remainder of the system was intact and able to use any fresh supply of the precursor. For if the sensitive substance is a precursor and not a product of the gene in question, it ought to be present in individuals of various genotypes, irrespective of their possession of suppressor-erupt and nonsuppressor alleles. These contemplated experiments are technically of great difficulty, because of the necessity for injecting material or transplanting tissues into very young and small *Drosophila* larvae. The third instar larvae customarily used as recipients are much too advanced in differentiation to serve in the present case. Still, it is hoped that indicative results can be obtained.

Nature of the Action of Suppressor Genes

Another approach would be to identify the exact chemical reaction controlled by one of these suppressor genes and then to determine whether the reaction is blocked by x-rays because of the destruction of the specific precursor or product. The analysis of biochemical, lethal mutations in *Neurospora* and in bacteria lends itself to this type of attack; but the small amount of differentiation existing in such organisms and the lethal nature of the mutations employed do not render it surprising that enzymes—such as tryptophan synthetase, to take an example—are active throughout most, if not all, of the life-cycle. Practically all that can be deduced is that when, on account of mutation, an essential gene is altered to an ineffective counterpart, the specific enzyme under the control of the gene disappears gradually, over the course of several cell generations, as though it at once had ceased to be renewed and was undergoing serial dilution to extinction.

A biochemical approach to the analysis of the action of the *Drosophila* suppressor genes was opened when it was discovered that an increase in the amount of tryptophan in the food upon which the larvae feed—up to 1 percent of the dry weight of the medium—would lead to an inhibition of the erupt-suppressor and tumor-suppressor genes nearly comparable in degree to that produced by x-raying the eggs or larvae with a dose of 1000 roentgens (*8–10*). Plaine further demonstrated that both the x-ray effect and the tryptophan effect of cysteine (*11*).

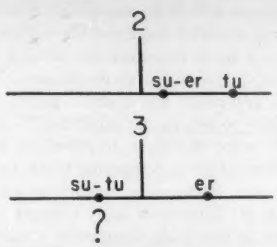

Fig. 3. Diagrams of chromosomes 2 and 3 of the double-suppressor strain. The approximate locations of the two mutants *tu* and *er* and their respective suppressors are indicated. *Su-tu* has not been located very exactly.

medium supplemented with 0.5 percent can be nullified by feeding larvae on a

The clue seems to be provided by the fact that the initial step in the degradation of tryptophan is its conversion to formylkynurenine by a coupled peroxidase-oxidase reaction. Cysteine, by reacting with the hydrogen peroxide or organic peroxides formed by ionizing radiation in tissues, would be expected to reduce the formation of formylkynurenine from tryptophan; or it would reduce the amount of peroxide normally present in tissue, so that, in the case of an excess supply of tryptophan, the latter substance could not be utilized in this particular reaction. It has thus become possible, by controlling the diet of larvae of the double-suppressor strain, to turn the action of the suppressors off and on again, at will. From this observation there has emerged a hypothesis that the suppressors themselves regulate the utilization of tryptophan in various competing pathways.

For animals, tryptophan is of course an essential amino acid. It cannot be synthesized through the coupling of indole and serine by tryptophan synthetase, as in plants and microorganisms. It is utilized in a number, perhaps a large number, of different ways (Fig. 5). It is incorporated into proteins; it is a source of the potent hormone serotonin (5-hydroxytryptamine); by way of kynurenine, it leads to the production of the brown eye-color pigment of *Drosophila* and other ommochrome pigments in other animals, and in plants to nicotinic acid and nicotinamide; and in plants, if not in animals, it is a source of the auxins which control various aspects of growth and tropic behavior. Tryptophan is thus the center of a nexus of biochemical reactions having profound consequences.

If the supply of tryptophan is normally limited in amount, the several channels of utilization must in a sense be competitive, and normal growth and differentiation will require a well-coordinated timing in the opening and closing of these channels, or the enlargement or restriction of flow along them. Thus meaning can be seen in the observations of Erk that kynurenine is present in the self-contained embryo but absent later; or that a free pool of tryptophan cannot be demonstrated to exist in the embryo, larva, or adult but is plentiful in the

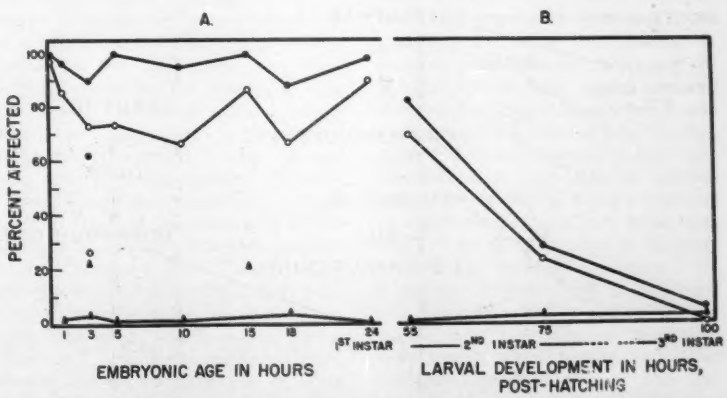

Fig. 4. Percentages of individual fruit flies of the double-suppressor strain manifesting erupt eyes when treated with 1000 roentgens of x-rays at various ages. ●, Percentage manifesting erupt to any degree, x-rayed series; ○, percentage manifesting extreme erupt, x-rayed series; ▲, percentage manifesting erupt to any degree, untreated control series (Glass and Plaine, *3*).

pupa; or, as has been mentioned, that kynurenine in the course of larval life is formed only in the gonads and Malpighian tubules.

Would it then be surprising if, as I have suggested elsewhere, the primary action of suppressor genes is exerted on quite different processes from those suppressed or enhanced? If the biochemical blocks produced by mutants in such a nexus of related processes stemming from a single point are not absolute, but, in the biochemical geneticist's phraseology, are "leaky," then the damming up of one channel may be sufficient to increase the flow past the leaky block. The evidence is clear that tryptophan itself does not accumulate to any great extent in the larvae. It is perforce used in one channel if not in another. The utilization in different ways consequently cannot be independent, and a mutant blocking one channel must influence the flow along others. A mutant blocking one channel might, in other words, act as a suppressor of a mutant blocking, or partially blocking, a different pathway. This is a more general explanation of the frequently observed nonspecificity of suppressor genes than to suppose that a suppressor gene must in some way remove an inhibitor from or repair a deformity in the very enzyme controlled by the mutant suppressed. In cases of suppressor specificity, the latter mechanisms might apply; in cases of nonspecific suppressors, a more general relationship must be sought.

A finding of paramount importance in this study was that the application of x-rays to embryos of the double-suppressor strain (*su-er; er*) produces erupt eyes, whereas the application to wild-type heterozygous for erupt (*su-er*$^+$; *er*$^+$/*er*) does not (*3, 12, 13*). In other words, the x-rays affect the action of the suppressor-erupt gene but do not affect the action of the normal allele of erupt —whence it may be concluded that the normal allele of erupt and the suppressor of erupt do not produce the normal eye phenotype by the same mechanism. The same end-result but distinct paths, one sensitive to x-rays, the other not!

We were therefore impelled to look for alternative or competing biochemical pathways. With these considerations in mind, E. Glassman and I began the search in the double-suppressor strain of *Drosophila*, and in the wild-type and other mutant strains as well, for the enzymes responsible for the conversion of tryptophan to kynurenine, 3-hydroxykynurenine, and the brown eye-color pigment (*14*). The vermilion mutant type is blocked in the formation of kynurenine from tryptophan. An enzyme system capable of producing kynurenine from formylkynurenine was readily found, its presence serving to confirm the belief that kynurenine is produced in *Drosophila* from tryptophan by way of formylkynurenine. However, the enzyme was omnipresent, in all stages of life and in all wild-type and mutant strains tested.

On the other hand, painstaking tests served only to confirm the surprising negative results of other workers: tryptophan peroxidase could not be found at all, even in pupae when there is a free pool of tryptophan, or in third instar larvae, when kynurenine is known to be formed in the gonads. Presumably, formation of the enzyme is extremely restricted, both in *site* and in *time*. Since the vermilion mutant form does contain kynurenine formamidase (the enzyme that converts formylkynurenine to kynurenine), the *v* block cannot be at that step but must involve the prior conversion of tryptophan to formylkynurenine. Green (*15*) has reported an accumulation of tryptophan in vermilion-eyed flies, but our tests show that this accumulation either is not sufficient to bring about an inhibition of the tumor and erupt suppressors, or more likely occurs only in the pupal and adult stages of life when the formation of melanotic tumors and differentiation of the eyes are past. Although it has also not been possible to show any effect of the tumor and erupt suppressors on the expression of vermilion, a distinction between the tumor and erupt suppressors has been found in the effect of feeding kynurenine to the larvae, for the feeding of kynurenine fails to inhibit the suppressor of erupt but does overwhelm the tumor suppressor (*8, 10, 16*).

In the still fruitless effort to isolate those enzyme systems responsible for converting kynurenine, by way of 3-hydroxykynurenine, to subsequent intermediates on the pathway to the brown eye-color pigment, Glassman discovered another phenomenon of great interest (*17*). This was an influence of tyrosinase and tyrosine on the disappearance of kynurenine or hydroxykynurenine in the formation of a dark-colored pigment *in vitro*. When dihydroxyphenylalanine was supplied, tyrosinase and tyrosine proved to be unnecessary. Experiments then demonstrated that a similar formation of pigment would occur spontaneously whenever any quinone was combined with an aromatic amine, such as kynurenine or hydroxykynurenine.

The production of these "aminoquinone" pigments suggests a simple explanation of a puzzling nonspecific suppressor gene action which has become virtually a classic case—namely, the suppression by a single *Drosophila* suppressor gene of both the vermilion eye-color and sable body-color mutants. The puzzling element has been the lack of any known connection between the biochemical formation of the ommochrome pigments, derived from tryptophan, and the melanins, derived from tyrosine.

Why should a restoration in the production of the brown eye-color pigment, which is an ommochrome, result simultaneously in a diminution in the production of melanin? If, according to the scheme depicted in Fig. 5, the brown eye-color pigment is an aminoquinone complex, formed from a quinone derived from tyrosine as well as from the aromatic amine hydroxykynurenine, and if the available supply of the quinone in the body is limited, then obviously a restoration in the blocked supply of kynurenine brought about by the suppressor of vermilion, either directly or indirectly, would once again draw upon the supply of quinone and consequently reduce the amount available for deposition in the hypodermis under the influence of the mutant sable.

This is clearly not the entire story. It fails to account for the tissue-specific aspects of pigment formation: Why is om-

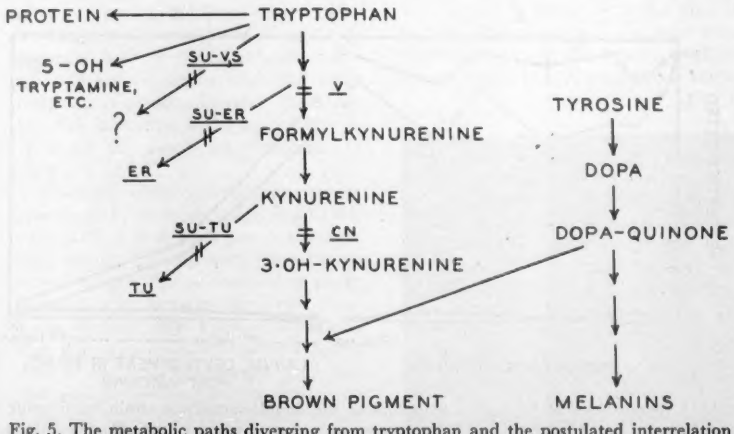

Fig. 5. The metabolic paths diverging from tryptophan and the postulated interrelation between tryptophan metabolism and tyrosine metabolism. The steps blocked by vermilion and cinnabar are marked by transverse bars, and the postulated steps blocked by various known suppressor genes that affect tryptophan metabolism are similarly indicated.

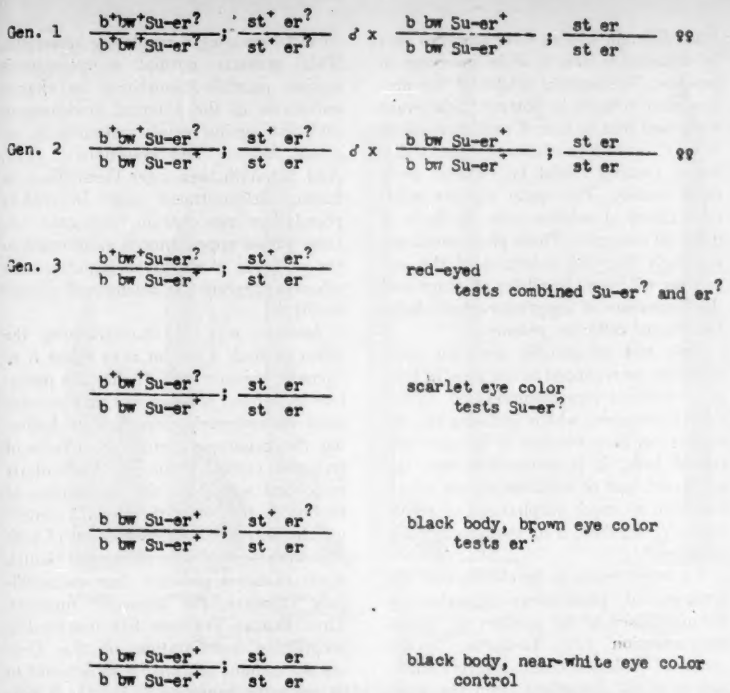

Fig. 6. Scheme of the crosses used to investigate the constitution of wild-type strains with respect to the alleles at the suppressor-erupt and erupt loci. *b*, Black (body color); *bw*, brown (eye color); *st*, scarlet (eye color); *er*, erupt eye; *Su-er*, suppressor of erupt eye. + Superscript: +, wild-type alleles of the aforementioned mutants; ?, alleles of unknown nature and potency which are being tested.

mochrome formed only in the eye, and melanin chiefly in the hypodermis? Or why does the suppressor of vermilion not reduce the melanin pigmentation of the wild-type or of other melanic mutants such as ebony and black? But such differences may lie at later stages of each pathway; certainly the tissue-specific effects must do so.

What is most encouraging is the way in which the discovery of the long-suspected connection between the formation of pigments from tyrosine and tryptophan permits an explanation of the possible mode of action of nonspecific suppressor genes that supports the hypothesis previously developed on the basis of the study of the erupt and tumor suppressors. The gene interactions postulated here resemble some of the theoretical schemes drawn up by Strauss and reinforce his conclusion that "the gene interaction obtained is not in any sense an interaction of the genes themselves, but is rather an interaction of the gene-controlled step reactions in non-genic parts of the organism" (*18*).

General Distribution of Suppressor Systems

The high frequency with which, in *Neurospora*, bacteria, and *Drosophila*, apparent reverse mutations have been found to be in actuality the result of mutations at a different locus that suppress the expression of the mutant—or, put otherwise, restore the normal or original phenotype—is well known. Surely every geneticist who works with such phenomena must be impressed with the remarkable capacity of developing organisms to achieve the same goal by various means.

These suppressor genes are not limited in occurrence to laboratory experiments. The discovery in my laboratory of the existence in a single strain of *Drosophila* of two independent suppressor systems, concealing the presence of two presumably detrimental mutants, made me, of course, curious to know how many other wild-type strains (insofar as erupt eyes and melanotic tumors are concerned) might be concealing these mutants by virtue of their possession of the suppressors. Assuming that the expression of these mutants is to some degree detrimental, would they not be entirely neutral when suppressed? Might they not even have effects which, not altogether suppressed, could in certain circumstances become advantageous? In other words, what would be the relative selective merits of the nonsuppressor coupled with the normal allele of the mutant, as against the suppressor coupled with the mutant?

The analysis has so far been carried out only with the suppressor-erupt system (*12, 19*). Because of the fortunate placement of the suppressor and the mutant in different chromosomes, already marked in the original strain by the mutant eye colors brown and scarlet, it was possible without great difficulty to develop a test strain for the erupt system. This test stock carried *bw* in chromosome 2 but no suppressor of erupt; in chromosome 3 it carried *er* and *st*. Flies of different wild-type laboratory stocks and samples of different natural populations could be crossed to the tester stock, and F_1 males could then be backcrossed to the tester strain. The resulting progeny (Fig. 6) would segregate into four eye-color types (wild-type dark red; scarlet; brown; and very pale brown scarlet), representing the inheritance from the wild-type strain, respectively, of both chromosomes 2 and 3, of chromosome 2 only, of chromosome 3 only, and of neither.

The fourth of these classes is the reconstituted tester strain and serves as a control to rule out any significant effect of either the sex or fourth chromosomes on the expression of the character. Fifteen wild-type strains collected from various parts of the world and kept in laboratories with more or less inbreeding for a period of years were tested in this way; and to them were added some freshly collected samples of wild populations from St. Louis, Mo. The results may be summarized very briefly.

No evidence was found for any suppressors of erupt in the X- or fourth chromosomes. Although the evidence is not conclusive that the suppression of erupt by the various second and third chromosomes tested was entirely located at the two loci of the suppressor of erupt in chromosome 2 and of erupt in chromosome 3, these loci must at least be responsible for the principal amount of effect. Great differences were found between strains and also within strains. No stock appeared to be homogeneous for erupt suppressors, except the long-inbred Florida-19 stock. Some strains possessed strong suppressors in chromosome 2 with potent "normal" alleles of erupt in chromosome 3. Some possessed potent "normal" alleles of erupt but weak suppressors. Others possessed strong suppressors in chromosome 2, but very weak "normal" alleles of erupt, even to the point of producing the erupt phenotype. From a number of stocks, such as Swedish-b and Urbana, it has proved possible to isolate erupt itself. Eggs of these wild-type strains, when x-rayed with 1000 roentgens, produce characteristic frequencies of erupt-eyed flies. In short, not only the laboratory-kept wild-type strains, but also the freshly collected ones, are almost universally seeded with the erupt mutant; but because of the sup-

pressors and wild-type alleles also present, the erupt phenotype was never observed, or at least reported, prior to my own analyses.

By comparing the relative strengths of the second chromosome suppressors of erupt (Fig. 7), and also those of the several normal alleles of erupt of differing potency (Fig. 8), it can be concluded that at least five significantly different strengths of suppressor and a like number of different normal alleles of erupt exist in a variety of naturally occurring combinations. Particularly noteworthy is the fact that in every case the combination of a suppressor in chromosome 2 and the normal allele in chromosome 3 (individuals of the wild-type eye color in our four-type segregation) produces a far greater suppression of erupt than would be expected from an additive effect of the two (Fig. 9). Consequently, when erupt does occur in a population and is heterozygous, as is usually the case, it is completely suppressed because of the multiplicative interaction of its own normal allele with the two genes at the suppressor locus.

Several studies by other geneticists have revealed a similar situation in *Drosophila*. Gardner *et al.* have reported the existence of a considerable variety of modifiers of two tumorous-head genes in eight tested wild-type strains (*20*). More similar to the erupt and suppressor-erupt phenomena is a situation described by Sturtevant (*21*) at the meeting of the American Institute of Biological Sciences in Storrs, Conn., last summer. Isoalleles of scute and of achaete, derived from different strains, were found to vary in dominance over a wide spectrum in potency. The normal alleles of the mutant also differed in potency. Sturtevant estimated that at least 4, and more likely 10 to 15, wild-type alleles of scute of different potency could be isolated from these strains. The quite distinct wild-type alleles of achaete were similarly of different strengths. These phenomena are strikingly like the existence of the numerous wild-type isoalleles of erupt and the occurrence of suppressor-erupt alleles likewise of different potency.

This sort of genetic situation must therefore be regarded as not rare, in fact, as probably a very common one. In my own experience, which includes the investigation of a number of loci not discussed here, it is commoner than the polygenic type of modifier system which has been so much emphasized in recent years. What, then, is its evolutionary significance?

To me it seems to fit clearly into the category of phenomena regarded by Schmalhausen as the product of "stabilizing selection" (*22*). To quote: "In the course of evolution due to a severe elimination of all deviations from the well-adapted standard form, a more or less complicated system of regulating (inclusive of buffering) mechanisms is created. This system tends to preserve normal development when the deviation from the standard of both internal and external factors is not too great" (*22*; quotation cited from Lerner, *23*, p. 103). And elsewhere, Schmalhausen has said, "Stabilizing selection produces a stable form by creating a regulating apparatus. This protects normal morphogenesis against possible disturbance by chance variations in the external environment and also against small variations in internal factors (i.e., mutations)" (*24*). And Schmalhausen cites Gershenson as having demonstrated that *Drosophila* populations may contain "dominant mutants whose appearance is suppressed in the genotype of the given population or whose appearance is attenuated considerably."

Another way of characterizing the effect of such a system is to relate it to "genetic homeostasis." If they are prevalent in natural populations, such systems must be extremely important in buffering the genotype against the effects of frequent, critical mutations. Particularly important would be the suppression of mutations that alter the "switch genes" which control the differentiation of serially homologous structures, and which when mutated produce that extraordinary category, the homeotic mutants. Thus Buzzati-Traverso has observed a progressive amelioration of the *Drosophila* mutant aristopedia subsequent to its origin by mutation (*25*). (It is possible, one might note, to regard erupt itself as a homeotic mutant, one in which a portion of the eye develops as an antennalike structure—but this may be a rather superficial view.) In any case, it seems to me that a new chapter might be added to Lerner's book on *Genetic Homeostasis* (*23*) in order to deal with this kind of system over and above the polygenic ones so well analyzed in it. Thus Lerner (*23*, p. 103) comments that Schmalhausen failed to visualize developmental homeostasis "as the specific property of heterozygotes." It seems, however, that it is also a property of epistatic, that is, suppressor-systems, and the distribution of these in Mendelian populations in differently balanced combinations satisfies Lerner's definition of genetic homeostasis as "the property of the population to equilibrate its genetic composition and to resist sudden changes" (*23*, p. 2).

If organisms can maintain the "normal" phenotype by a variety of genetic systems which restore the balance between competing biochemical pathways, then the evolution of isolated populations might well be expected to diverge in respect to possession of suppressor systems of different composition. The divergence might be virtually at random and might be promoted by random genetic drift, unless the particular components of the gene system in question have subsidiary phenotypic effects which would subject them to the action of natural selection. In the latter case, just as new genes have been postulated to arise through the divergence in function of duplicated genes,

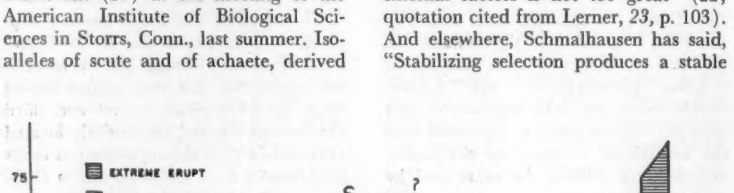

Fig. 7. Effect of a single dose of the unknown suppressor-erupt allele from a wild-type strain tested against a nonsuppressor allele and homozygous erupt. The slopes at the tops of the bars represent the difference between the highest and lowest values for the strains in each group.

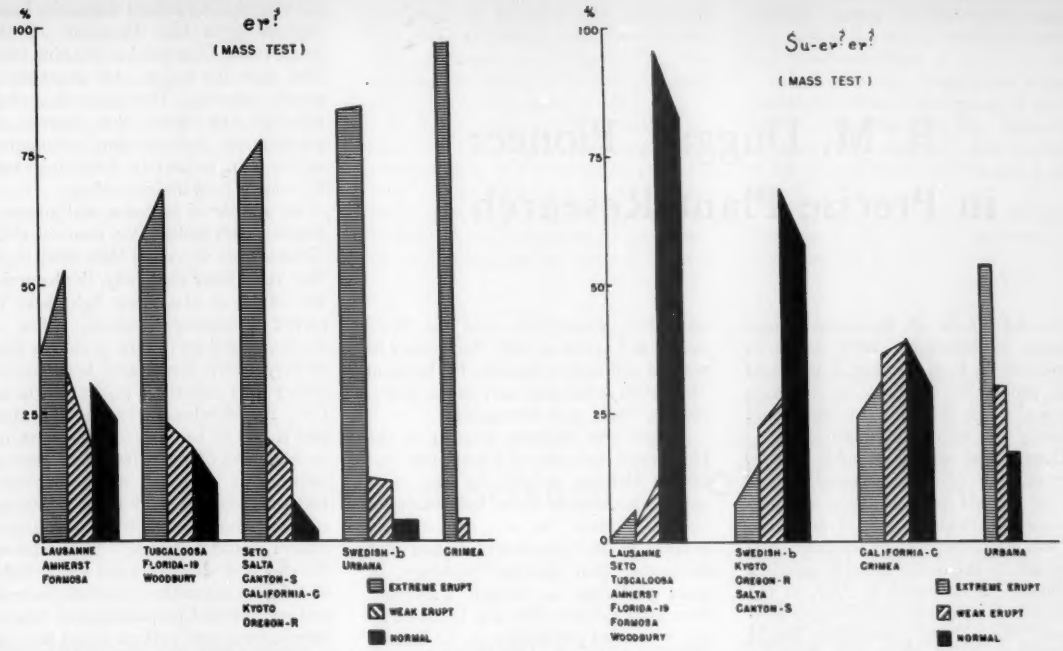

Fig. 8 (Left). Effect of a single dose of the unknown erupt allele from a wild-type strain tested against an erupt allele and homozygous nonsuppressor. Fig. 9 (Right). Interaction of single doses of both the unknown suppressor allele and the unknown erupt allele from a wild-type strain, tested against one nonsuppressor and one erupt. The slopes at the tops of the bars represent the difference between the highest and lowest values for the strains in each group.

so too new genes might arise through the divergence of balanced "suppressor-plus-mutant" systems. A mutant gene that is neomorphic in nature and that is inadequately suppressed in respect to its adverse effects by its own normal allele may be tolerable when it is suppressed by a gene at another locus and may then have an opportunity to become established on the basis of its subsidiary, advantageous effects, if any.

With this reasoning in mind, an attempt was made to determine whether *Drosophila simulans* and other *Drosophila* species carry an established erupt-suppressor-erupt system (*12, 19*). Hybrids between *D. simulans* (from several geographic regions) and *D. melanogaster* erupt proved to be mostly wild type, but 2 to 8 percent were strongly erupt, in respect to the eye. The results were very similar to those from the majority of the *D. melanogaster* wild-type strains. In other words, *D. simulans* does in fact carry an established suppressor-erupt gene. (An earlier report to the contrary (*12*) is attributable to the fact that many of the hybrids between *D. simulans* and *D. melanogaster* have very disarranged eye facets, which may be confused with erupt.) *Drosophila simulans,* as well as several species which cannot be hybridized with *D. melanogaster,* were further tested by exposing the embryos to 1000 roentgens of x-rays. This test, of course, would detect only the presence of the entire system consisting of the suppressor plus the erupt mutant. The results were somewhat inconclusive, but in general no clear sign of the presence of erupt in combination with its suppressor was found in these species. The suppressor is thus more widely distributed than erupt itself, and the balanced system as a whole is of recent evolutionary origin.

The trail leads on into more and more engaging areas of investigation. Let me then conclude by reasserting my belief that in the pursuit of the gene there is merit in sticking to a single trail until the quarry is treed. At least in some instances, most of the major unsolved questions of genetics and development will become involved, and some measure of enlightenment may follow (*26*).

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B. M. Duggar, Pioneer in Precise Plant Research

In the death of Benjamin Minge Duggar, 10 September 1956, American science lost a keen intellect, a profound and productive scholar, an inspiring teacher, a wise scientific statesman, and a kindly and stimulating personality.

Duggar had an exceptionally active, incisive, and penetrating mind, which he put to work with precision and persistence on a wide variety of problems. He was motivated both by scientific curiosity and by the desire to solve practical problems. As he wrote in 1909, in the preface to his pioneer book *Fungous Diseases of Plants,* "The presentation should be fundamental, but it should also bear a close relation to the affairs of life." Although Duggar sought final explanations for phenomena and final solutions to problems, he did not disdain proximate explanations and solutions; he appreciated the evolutionary nature of progress in the fields of his special interest, plant physiology, plant pathology, economic botany, and industrial microbiology.

Although he was critical, Duggar's criticism was constructive and optimistic; he continually encouraged attempts to gain deeper insight into problems and broader vision regarding them. He contributed not only to knowledge but also to improved methods for gaining it; his contributions were not only factual and methodological but also philosophical.

Duggar was always progressive; his mind was always young. He helped his fields of science to grow, and he grew with his fields of science. He was always willing to teach, but he was always avid to learn also; he was always a productive scientist, and he was always an acquisitive scholar. He was a willing and effective talker and writer, but he was also an efficient listener and reader; his was an exceptionally acquisitive and productive intellect.

Born at Gallion, Alabama, in 1872, young Duggar attended the University of Alabama for 2 years, then obtained the B.S. degree, with first honors, at Mississippi Agricultural and Mechanical College in 1891 and the M.S. degree at Alabama Polytechnic in the following year. He then obtained the A.B. and the A.M. degrees at Harvard University in 1894 and 1895, respectively, and the Ph.D. degree at Cornell in 1898. Apparently he wanted still more education for he spent 1899–1900 at German universities and at Naples, Paris, and Montpelier.

Duggar was assistant director of the Uniontown Agricultural Experiment Station in Alabama in 1892–93. After serving in the Illinois State Laboratory of Natural History, he was cryptogramic botanist in the experiment station and instructor, then assistant professor, in plant pathology at Cornell University from 1895 to 1901. This was followed by a year as plant physiologist in the Bureau of Plant Industry of the U.S. Department of Agriculture, 5 years as professor of botany at the University of Missouri, and 5 years as professor of plant physiology at Cornell. After 15 years as research professor of plant physiology at the Missouri Botanical Garden and Washington University, he became professor of physiology and economic botany at the University of Wisconsin in 1927, where he remained until his retirement to emeritus status in 1943. Even then Duggar's intellectual and physical energies did not subside, and he became consultant in mycological research and production to the Lederle Laboratories Division of the American Cyanamid Company.

As a plant physiologist and economic botanist, Duggar made important contributions to many fields of plant science. Among his early publications there appear titles such as "The sterile fungus *Rhizoctonia*—as a cause of plant diseases in America" and "The cultivation of mushrooms." The book *Fungous Diseases of Plants* was long a standard textbook in plant pathology. His studies on the effect of bordeaux mixture and of dusts and surface films on the rate of transpiration of plants indicated a continuing interest in plant diseases, as did researches in his laboratory on the nature of fungicidal action. He and his students also studied many phases of the physiology of plant pathogens and issued a series of publications under the general heading "Studies in the physiology of fungi."

Later, he also developed a deep interest in the nature of plant viruses. Characteristically, Duggar wrote in 1928, "At the risk of being judged dogmatic, I must exclude from this discussion all that seems to me inessential in focusing attention upon the nature and properties of mosaic agencies." This was typical of the man; he saw clearly that progress depended on understanding phenomena rather than on merely describing them. He sought final understanding.

An apostle of precision and accuracy, Duggar, with Hollaender, wrote in 1933: "The effects of visible light and, in recent years more especially, the bactericidal effects of ultraviolet light have received increasing attention. Most of those engaged upon such problems prior to very recent years have been content with results essentially qualitative in nature. Nevertheless, progress was made and it was to be expected that with the development of vastly improved physical instruments available to the biologist, and with analogous advances in biological technique, definitely quantitative studies would be made." In comparing the effects of ultraviolet and visible lights of different intensities on certain bacteria and semipurified preparations of tobacco mosaic virus, the authors found that the ratio of virus resistance to that of the bacteria was 200 to 1. The results of these and similar researches were important, but even more important were the contagiousness of Duggar's precise methodology and the clarity of his thinking. He taught a generation much about the aims and methods of plant research.

"Some factors in research" is the title of a paper read by Duggar in 1918 a symposium on "Our Present Duty as Botanists." Intimating that certain fields of the applied sciences in agriculture had sown practical gardens and orchards and had reaped garden and orchard practice, Duggar bespoke more sympathetic and thorough consideration of fundamental physiological, pathological, and genetical problems; otherwise, the alleged sciences would comprise merely practical and managerial skills. He also foresaw the importance of plant research positions in various industrial enterprises. His visions became realities, and he was importantly influential in the realizations.

His books included, in addition to *Fungous Diseases of Plants, Plant Physiology,* published in 1911, *Mushroom Growing,* 1915, and *Textbook of Botany,* with G. M. Smith and others. He was a strong supporter of *Botanical Abstracts* and acted as its editor for physiology from 1917 to 1926. This was followed by a similar service to *Biological Abstracts,* from 1926 to 1933, and to *Biological Abstracts of Radiation* in 1926.

Duggar was a member of various scientific societies. He was vice president of Section G of the AAAS in 1925, president of the American Society of Plant

Physiologists in 1946–47, and chairman of the Division of Biology and Agriculture of the National Research Council in 1925–26. His services were sought in numerous national and international committees because he was as effective in such activities as in everything else that he undertook. He was genuinely and effectively public-spirited.

Among the honorary societies of which he was a member were Phi Beta Kappa, Sigma Xi, Phi Sigma, the National Academy of Sciences, the American Philosophical Society, and the Philadelphia Academy of Science. He was awarded the Medal of Honor of Public Education in Venezuela in 1951.

Duggar's services and honors were manifold and diverse. His advice was widely sought by his numerous graduate students and colleagues and was always freely and cheerfully given. He furnished leadership and inspiration in plant sciences during a period when they were urgently needed; he was erudite and he was useful; he was a profound scholar and an efficient doer.

Benjamin Minge Duggar was a great leader, by virtue of the power of his intellect, by virtue of the disciplined strength of his character, and by virtue of his helpful humanity. He was a great man.

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News of Science

Swedish Geophysical Observatory

The Kiruna Geophysical Observatory of the Royal Swedish Academy of Science was dedicated last summer. Representing a decade of planning, this new facility in northern Sweden will enable geophysicists interested in arctic phenomena to carry on research under the most favorable conditions. Bengt Hultqvist is director at Kiruna.

The location of the observatory is particularly significant with respect to the Geophysical Institute in Fairbanks, Alaska, because the two observatories are approximately 180° apart in longitude. This circumstance will make it possible for the two laboratories to undertake certain important types of transpolar research projects on a cooperative basis. Coordinates for Kiruna are as follows: geographic coordinates, North 67.8°, East 20.4°; geomagnetic coordinates, North 65.3°, East 115.5°. Similar coordinates for the Geophysical Institute at Fairbanks are: geographic, North 64.9°, West 147.8°; geomagnetic, North 64.5°, East 255.4°.

The Kiruna observatory consists of a main building and a number of small buildings for housing various types of instruments. It occupies a tract of 22.2 square kilometers, which provides amply for future expansion, including the establishment of auxiliary observing sites where measurements over base lines of several kilometers are desirable.

Main building of the Kiruna Geophysical Observatory.

The main building contains a series of laboratories, a combined seminar room and library, dining and lounging facilities, living quarters for investigators, a well-equipped mechanical workshop, and so forth. One large laboratory room can be subdivided into three small rooms if necessary, each suitable for one or possibly two workers. A second laboratory provides facilities for several persons, and five smaller rooms are equipped to accommodate either one or two people.

On the upper floor of the main building is a heated, glassed-in laboratory. Above this is an open deck on which can be mounted equipment requiring all-around seeing conditions. The mounting facilities are provided with supports that go down to foundation material that is independent of the building structure itself. A grant from the U.S. National Science Foundation has helped to equip the observatory with good basic instrumentation.

A special board of the Royal Swedish Academy of Science has been responsible for the planning of the new observatory. This board, which has 11 members, is headed by R. Sandler, president, and R. Sievert, vice president.

Since the dedication, Director Hultqvist has announced that the observatory welcomes suitable research proposals, particularly when appropriate financial support can also be provided. All proposals for cooperative activities should be addressed: Director, Kiruna Geophysical Observatory, Kiruna, Sweden.

Cedar Creek Forest

A new laboratory building, which will make it possible to expand studies on wildlife and plant life in their natural surroundings, was dedicated at Cedar Creek Forest, Minn., on 14 Sept. by the

University of Minnesota and the Minnesota Academy of Science.

Cedar Creek Forest, which is located approximately 25 miles north of the Twin Cities in northern Anoka and southern Isanti counties, contains a wide variety of trees, other plants, and animal life. Among the trees are all three kinds of pine that are native to Minnesota, old prostrate junipers, white cedar, white pine, black spruce, and many species of hardwoods. Among the birds are ruffed grouse, Canada spruce grouse, Canada jay, and, occasionally, the rare arctic three-toed woodpecker. Deer are numerous, and other mammals of the northern forest can be found.

The forest will be administered as a natural history area—that is, it will be used primarily for observation rather than experimentation. Access for scientific and educational purposes, as well as for protection from fire, will be permitted. The administration will seek to conserve and if possible to develop the natural values of the area and to minimize the loss or depletion of plants and animals through hunting, collecting, fishing, picnicking, or other disturbances.

William S. Cooper, of the botany department of the University of Minnesota, first called attention to the Cedar Creek Bog, as it was then known, in 1937, when he described it to the Academy Committee for the Preservation of Natural Conditions. In 1939 the Academy approved the committee's recommendation that some effort should be made to preserve the area, and in 1942 the University agreed to accept and preserve the land if the Academy would obtain gifts from private sources to make the purchase possible. By 1953, 750 acres had been purchased.

Construction of the laboratory, purchase of additional land, and other improvements were made possible by a grant, in 1954, of $250,000 from the Max C. Fleischmann Foundation of Nevada. The laboratory building contains an office, a combination meeting room, classroom, and laboratory, a map and record room, three research laboratories, and small dormitories.

Studies now underway at the forest include a wildlife survey of a portion of the area, population studies on frogs, and studies on external parasites of mice. A three-year study on total plant yield under natural conditions was begun last summer.

Sky High

A new laboratory 17,000 feet high in the Bolivian Andes, to be used for the study of the effect of altitude on the human and animal body, will be set up shortly by the University of California's Donner Laboratory with the cooperation of Bolivian scientists and with the support of the Atomic Energy Commission and private donors.

The altitude chosen is considered to be about at the limit of human acclimation. When oxygen tension is low, the production of red blood cells increases tremendously. Immediate plans call for an attempt to isolate a humoral factor that appears to stimulate production of red blood cells.

Three American scientists will remain at the high Bolivian laboratory for a month. Thereafter, the Bolivian scientists will continue research with collaboration from the California group. Much of the biological material taken at the Bolivian laboratory will be shipped to California for analysis.

Temperature Test Facility

An elevated temperature test facility which can duplicate the intense heat developed by missiles from atmospheric friction at high velocities has been developed by Westinghouse Electric Corporation.

The facility, which consists of an analog regulator, graph recorder, and multiple banks of infrared lamps, can create a 2500-degree temperature in 12 seconds. This will make it possible for aircraft builders and designers to pre-test structural parts in simulated flights.

The regulator controls the "flight pattern," proportioning the output of the infrared lamps to generate the amount of heat produced at various speeds. In actual practice, the missile or aircraft component, such as a nose cone or wing section, would be loaded to produce the aerodynamic stresses expected during flight. The theoretical flight is plotted on the graph recorder; by means of the plot, the "flight" may be checked to assure that all conditions of speed and heat were accurately reproduced.

NAS–NRC Medical Science Awards

The Division of Medical Sciences of the National Academy of Sciences–National Research Council has announced that applications for postdoctoral research fellowships for 1958–59 will be accepted *until 1 Dec.* Further information may be obtained from the Medical Fellowship Board, NAS–NRC, 2101 Constitution Ave., NW, Washington 25, D.C.

Two fellowship programs are offered: National Research Fellowships in the Medical Sciences and Donner Fellowships for Medical Research. The latter were initiated in 1956 with the support of the Donner Foundation of Philadelphia.

These programs are designed to provide research experience in the basic medical sciences for people who plan careers in academic medicine and investigation. Fellows are expected to devote their entire time to research, and funds are not available for support of practical experience in the clinical field. Awards are open to citizens of the United States and Canada who hold the M.D., Ph.D., or Sc.D. degree. Ordinarily fellowships are not granted to persons over 35 years of age.

The Division of Medical Sciences has also announced, on behalf of the James Picker Foundation, the continued availability of funds in support of radiological research. The program is oriented toward, but not necessarily limited to, the diagnostic aspects of radiology. Support is not restricted to citizens of the United States or to laboratories within this country.

Three distinct types of support are offered:

1) *Grants-in-aid* are awarded to institutions for support of specific research projects.

2) *Grants for Scholars* are a transitional form of support, designed to bridge the gap between the completion of fellowship training and the period when the young scientist has thoroughly demonstrated his competence as an independent investigator. The application is submitted by the institution on behalf of the prospective scholar. Grants of $6000 per year are made to the institution as a contribution toward the scholar's salary, or his research, or both.

3) *Fellowships in Radiological Research* are open to candidates seeking to gain research skills leading to investigative careers in the field of radiology. Candidates holding the M.D., Ph.D., or Sc.D. degree are eligible, but those trained in radiology who are 35 years of age or less will receive preference.

Applications for Picker awards for 1958–59 should be received at the NAS–NRC *by 1 Dec.* However, it should be noted that within the next year the National Research Council of Canada will assume the responsibility for serving as scientific adviser to the Picker Foundation with respect to its Canadian program.

Scholarships

The U.S. Office of Education has reported that 237,000 scholarships having a monetary value of $65.7 million were available to undergraduate college students in the school year 1955–56, com-

pared with only 124,000 scholarships, worth approximately $27 million, in 1950–51.

The survey also indicated that, in 1955–56, 1562 institutions of higher learning, which enroll more than nine-tenths of the college and university students in the country, reported some form of student financial aid. This figure compared favorably with the figure for 1950–51, when 1198 institutions reported that they gave scholarship aid.

These facts and figures are part of a survey released by the Office of Education which is intended to keep parents and young people informed of the types and amounts of financial aid available. Copies of two publications bearing on the subject, "Financial Aid for College Students: Undergraduate" and "Financial Aid for College Students: Graduate" can be obtained from the Superintendent of Documents, U.S. Government Printing Office. ($1.00 and $0.50, respectively).

News Briefs

Industrial Exhibitions Limited of England has announced that the 1958 Instruments, Electronics, and Automation Exhibit will be fully international for the first time and that overseas firms will be able to show their products at its exhibition in London. Further information can be obtained from Industrial Exhibitions Limited, 9 Argyll Street, London W.1.

* * *

The Sister Elizabeth Kenny Foundation has announced that it will continue to award post-doctoral scholarships to promote work in neuromuscular diseases. Depending upon the applicant's qualifications, grants vary from between $5000 and $7000 a year for a 5-year period. Appointments are made annually. Those interested may write to Dr. E. J. Huenekens, Medical Director, Sister Elizabeth Kenny Foundation, 2400 Foshay Tower, Minneapolis 2, Minn.

* * *

The National Cancer Institute's 20th anniversary was celebrated by a special symposium in the August issue of the *Journal of the National Cancer Institute*, which took note of both the growth of the Institute's program and progress in research during the past 20 years.

* * *

A 73-page paper-bound booklet entitled "U.S. Research Reactors" has been released by the Atomic Energy Commission. It describes more than 30 research reactors and contains drawings, photographs, and charts; it was prepared for scientists, engineers, and administrators. The reactors are grouped according to major types, and one or two examples of each are described at some length as typical examples. The booklet is available from the Office of Technical Services, U.S. Department of Commerce ($1.50).

* * *

A new series of 13 educational television programs entitled "The World of Medicine" has just been launched under a grant from the Schering Corporation. Among the programs to be included in the series are "The nurse," "Recovery room," "The eye," "Geriatrics," "Veterinary medicine," and "Allergy."

* * *

The third U.S. Atoms-for-Peace mission is currently visiting Central America, including Panama, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. The purpose of this mission, as of the two preceding ones which visited ten other Central and South American Republics, is a discussion of the programs for practical applications of nuclear energy in agriculture and medicine, and in nuclear education and training. The U.S. team is meeting with scientists, educators, and government officials of the six host countries.

* * *

Three Agriculture Department researchers have isolated a new chemical compound from the seeds of green beans and kidney beans. The compound, which may play an important role in the germination of bean seeds and in the metabolism of the plants, was discovered by Robert M. Zacharius, Clayton J. Morris, and John F. Thompson. It is a peptide, γ-glutamyl-S-methyl-cysteine, consisting of two amino acids—glutamic acid and S-methyl-cysteine—linked together.

* * *

The Atomic Energy Commission has issued a temporary regulation, effective 26 Sept. 1957, designed to give immediate protection to the public and to licensees and their suppliers against losses arising from reactor accidents. The regulation is based on Public Law 85-256, the indemnity legislation signed by the President on 2 Sept. The temporary regulation will provide protection while a permanent regulation is prepared, issued for public comment, and reissued as an effective regulation.

Public Laws

During the 85th Congress, which recently recessed, members introduced 14,013 bills. According to the *Congressional Quarterly*, this sets a new record for recent years, but the number of bills passed and signed into public law by the President was only 316, a number somewhat below the average for a first session of Congress. Those of the public laws that have a special bearing on science or education are as follows:

Public Law 155. HR 2460. Improve career opportunities of nurses, medical specialists of Army, Navy, and Air Force.

Public Law 164. HR 1058. Preserve key deer and other wildlife resources in Florida Keys.

Public Law 175. HR 9379. Fiscal 1958 appropriations for Atomic Energy Commission.

Public Law 177. HR 8992. Concerning the International Atomic Energy Participation Act.

Public Law 208. HR 7914. Amend Career Compensation Act of 1949 to provide incentive pay for human test subjects.

Public Law 245. S 268. Provide that the Secretary of the Army return certain mineral interest in land acquired by him for flood-control purposes.

Public Law 247. HJ Res. 404. Provide for recognition and endorsement of second World Metallurgical Congress.

Public Law 253. HR 3377. Promote national defense by authorizing construction of aeronautical research facilities and acquisition of land by National Advisory Committee for Aeronautics necessary to effective prosecution of aeronautical research.

Public Law 287. HR 8994. Amend Atomic Energy Act of 1954, as amended, to increase salaries of certain executives of the Atomic Energy Commission.

Public Law 296. HR 9280. Facilitate conduct of fishing operations in the Territory of Alaska, to promote conservation of fishery resources thereof.

Scientists in the News

NIELS BOHR, director of the Institute for Nuclear Physics, Copenhagen, Denmark, will receive the first $75,000 Atoms for Peace Award during a special convocation at the National Academy of Sciences in Washington, D.C., on 24 Oct. President Eisenhower will head the body of government and UN officials, scientists, diplomats, and industrial leaders invited to attend the convocation.

The award to be presented to Bohr is the first of ten to be granted to those persons anywhere in the world who have made the greatest contributions to the peaceful uses of atomic energy. The prize is given without regard for nationality, politics, or any other consideration except the merit of the contribution. Bohr was selected from among 75 candidates proposed by scientific bodies in 23 countries.

The Atoms for Peace Awards were created in 1955 as a memorial to Henry Ford and Edsel Ford. Funds are provided

by the Ford Motor Company Fund, which has authorized $1 million for the purpose.

Bohr's award will be presented by James R. Killian, Jr., president of Massachusetts Institute of Technology and chairman of the board of trustees of Atoms for Peace Awards. In addition to the $75,000 prize, Bohr will receive a sculptured gold medal that was executed by Sidney Waugh. Key address at the convocation will be delivered by Arthur H. Compton; sharing the platform with Compton will be John A. Wheeler of Princeton University, long a colleague of Bohr's.

Prior to the convocation, Bohr will be honored at a luncheon to be given by the president and council of the National Academy of Sciences. President Eisenhower is expected to be among the guests.

JACK G. MAKARI, former associate professor of immunology at the University of Texas and head of the section of immunology at the M. D. Anderson Hospital and Tumor Institute, has been appointed director of research at the Muhlenberg Hospital, Plainfield, N.J.

DONALD K. COLES, a member of the staff of Westinghouse Research Laboratories, has been appointed head of the solid-state laboratory at Farnsworth Electronics Co., Fort Wayne, Ind.

WILLIAM B. COOK, former acting program director for the Summer Institutes Program of the National Science Foundation, will assume new duties as head of the department of chemistry at Montana State College, Bozeman. Cook will be succeeded by GRANT W. SMITH, professor of chemistry at Pennsylvania State University. P. C. GAINES, retiring head of the department of chemistry at Montana State College, will remain at the college as vice president and dean.

At the National Science Foundation GEOFFREY KELLER, professor of physics and astronomy at Ohio State University, has been named program director for astronomy, Division of Mathematical, Physical, and Engineering Sciences; WALTER J. PETERSON, head of the chemistry department at North Carolina State College, has been named program director for special projects in science education, Division of Scientific Personnel and Education; and NELSON T. SPRATT, JR., professor of zoology at the University of Minnesota, has been named program director for developmental biology, Division of Biological and Medical Sciences. All three men are taking a year's leave of absence from their universities.

The following people received awards during the American Chemical Society's 132nd national meeting, which took place in New York, 8–13 Sept.

WILLIAM S. JOHNSON, Homer Adkins professor of chemistry at the University of Wisconsin, the ACS Award for Creative Work in Synthetic Organic Chemistry, sponsored by the Synthetic Organic Chemical Manufacturers Association, ". . . for his work in the total syntheses of steroids and related compounds."

JACOB BIGELEISEN, senior chemist at Brookhaven National Laboratory, the ACS Award for Nuclear Applications in Chemistry, sponsored by the Nuclear Instrument and Chemical Corporation, ". . . for his work on the isotopic effect in chemical reactions."

DUBOIS EASTMAN, director of research, Montebello, Calif., Laboratories of the Texas Company, the ACS Award in Industrial and Engineering Chemistry, sponsored by Esso Research & Engineering Company, ". . . for developing a new basic process for production of synthesis gas and hydrogen."

CARL DJERASSI, professor of chemistry, Wayne State University, the ACS Award in Pure Chemistry, sponsored by Alpha Chi Sigma Fraternity, ". . . for pioneer work on the structure of natural products and for his use of rotatory dispersion as a tool for analyzing conformational effects in complex molecules."

MAURICE F. HASLER, director of research, Aplied Research Laboratories, the Beckman Award in Chemical Instrumentation, sponsored by Beckman Instruments, Inc., ". . . for contributions to instruments and techniques suitable for industrial use of spectrochemical analysis."

WILLIAM G. GORDON, supervisory chemist in charge of protein structure unit, animal proteins section, Eastern Regional Research Laboratory of the U.S. Department of Agriculture, the Borden Award in the Chemistry of Milk, sponsored by the Borden Company Foundation, Inc., ". . . for definitive studies on alpha-, beta-, and gamma-casein, and of a-lactalbumin."

JAMES J. LINGANE, chairman of the chemistry department, Harvard University, the Fisher Award in Analytical Chemistry, sponsored by Fisher Scientific Company, ". . . for pioneer work in coulometric analysis and for defining the extent of the field and capacities of the coulometric technique."

GEORGE H. BUCHI, associate professor of organic chemistry, Massachusetts Institute of Technology, the Fritzsche Award, sponsored by Fritzsche Brothers, Inc., ". . . for outstanding contributions to structure determination of terpenes."

ARDA A. GREEN, research associate, McCollum-Pratt Institute, Johns Hopkins University, the Garvan Medal, ". . . for successful crystallization of the enzyme luciferase from firefly lanterns."

WILLIAM L. LAURENCE, science editor of the New York Times, the James T. Grady Award, ". . . for pre-eminence in interpreting science to the public."

PAUL H. EMMETT, professor of chemistry, Johns Hopkins University, the Kendall Award in Colloid Chemistry, ". . . for contributions to the Brunauer-Emmett-Teller method of measuring surface areas of solids."

LESTER J. REED, research scientist at the Biochemical Institute, University of Texas, the Eli Lilly and Company Award in Biological Chemistry, ". . . for his investigations on the chemistry and functions of lipoic acid, the most recently characterized member of the vitamin B complex."

EUGENE P. KENNEDY, professor of biochemistry, University of Chicago, the Paul-Lewis Award in Enzyme Chemistry, ". . . for investigation on lipide biosyntheses, in particular, the discovery of the role of cytidine nucleotides in the enzymic synthesis of lecithin."

ROBERT P. EISCHENS, chemist, Texas Company, the Precision Scientific Company Award in Petroleum Chemistry, ". . . for contributions to fundamental knowledge of catalysis in petroleum and its products."

FRANK E. BROWN, professor of chemistry, Iowa State College, the Scientific Apparatus Makers Award in Chemical Education, sponsored by Scientific Apparatus Makers Association, ". . . for enthusiastic concern to improve chemical education, and his efforts to promote the experimental approach in teaching chemistry."

JOHN L. GEORGE, former assistant professor of zoology at Vassar College, has been named associate curator of mammals at the New York Zoological Park.

ROBERT L. BOGNER, formerly a research pharmacologist in the department of pharmacology at the Walter Reed Army Institute of Research, has been appointed senior pharmacologist in the department of biology and medicine of the Nuclear Science and Engineering Corporation, Pittsburgh, Pa.

WALTER P. TAYLOR, until recently a faculty member at Claremont College, has been named visiting professor of zoology at Southern Illinois University. EDWIN C. GALBREATH, formerly of the University of Kansas Medical School at Lawrence, is another new member of the Southern Illinois zoology staff. He is serving as professor for research and teaching in vertebrate paleontology.

IAN AIRD, chief of the surgical service and head of the department of surgery at the Postgraduate Medical School of the University of London, England, will deliver the Charles H. Mayo Memorial Lecture at Northwestern University Medical School on 25 Oct. Aird, who is known for his contributions to abdominal surgery, will speak on "Pancreatectomy."

W. H. LARRIMER has been made director of the Office of the Handbook of Biological Data at the National Academy of Sciences–National Research Council. Larrimer's career in the U.S. Department of Agriculture has been about equally divided between entomology and forestry, with emphasis on research administration in both. He retired from the Forest Service in 1955.

WILLIAM H. CHARCH has received Columbia University's Charles Frederick Chandler Medal for 1957 in recognition of his outstanding achievements in the development of moisture-proof cellophane and of synthetic fibers. Charch is director of the Pioneering Research Division, Textile Fibers Department of E. I. duPont de Nemours and Company. His award lecture dealt with "Synthetic Fiber Structure and Property Relationships."

PAUL R. CANNON has retired after 17 years as chairman of the department of pathology at the University of Chicago. He has been on the university's medical faculty for 32 years. As professor emeritus, he will maintain an office and will continue as chief editor of the American Medical Association's *Archives of Pathology*.

Cannon is best known for his work on tissue antibodies and on the foods the body needs to maintain them. His earliest work proved that antibodies in tissues and cells are similar to those of the blood. Antibodies can increase or lessen tissue inflammation, depending on how they react to invading microbes.

To form antibodies, he found, human beings need steady quantities of eight protein-building amino acids. During infection or injury and after operations, extra amounts are needed. His recent studies have shown that the body needs potassium in order to use these proteins properly.

For his work in immunity and nutrition, Cannon in 1948 was given both the Ward Burdick Award-Medal of the American Society of Clinical Pathologists and the William Hood Gerhard Gold Medal of the Pathological Society of Philadelphia.

Cannon's interest in studying the prevention of disease led him to other areas of research. In 1931, with William H. Taliaferro, now chairman of the department of microbiology at the university, he was one of the first Americans to study rare, severe cases of malaria in human beings and to urge that this disease be combatted by bacteriological methods.

With Eugene M. K. Geiling, now retired chairman of the university's department of pharmacology, he found that diethylene glycol, a sweet, glycerinlike base of a new drug, had caused the deaths of 80 Americans in 1937. This research led to revision of the Pure Food and Drug Laws in 1939.

Cannon has also been a spokesman for academic pathologists, refuting the criticisms of some that autopsies are needless and after-the-fact. Post-mortem examinations, he recently told the House Interstate and Foreign Commerce Subcommittee on Health and Science, are being performed so rarely outside of academic institutions that "medical science is wallowing in a great deal of incomplete evidence."

Cannon took his A.B. degree from James Millikin University (Decatur, Ill.) in 1915, his Ph.D. in bacteriology from the University of Chicago in 1921, and his M.D. from Rush Medical College (Chicago) in 1926.

T. A. GEISSMAN, professor of chemistry at the University of California, Los Angeles, has been elected the first honorary fellow of the Royal Australian Chemical Institute. Geissman recently arrived in Australia for a 9-month stay on a senior Fulbright fellowship with the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization. He is a specialist in the chemistry of plant constituents and will join the CSIRO group working in this field.

JOSEPH E. IMBRIGLIA has been appointed professor and head of the department of pathology at Hahnemann Medical College. Imbriglia, who has been a member of the Hahnemann faculty since 1950, is studying the pathogenesis of arteriosclerosis by histochemical methods.

LEWIE C. ROACHE, associate professor of biology at South Carolina State College, Orangeburg, has been appointed head of the biology department. He has been a member of the college faculty since 1947.

ROBERT L. SINSHEIMER, formerly of Iowa State College, has been named professor of biology at California Institute of Technology. A specialist in the development and use of modern biophysical techniques, he has made original contributions to knowledge of the chemistry of nucleic acids. Another appointment at C.I.T. is that of JOHN TODD as professor of mathematics. He has been chief of the numerical analysis section at the National Bureau of Standards since 1954.

HOWARD J. LEWIS has been appointed director of public information for the National Academy of Sciences–National Research Council. A former magazine editor and free-lance writer, Lewis recently served as a reporter for *Scope Weekly*.

Recent Deaths

FREDERICK ANDERSON, Ottawa, Canada; 89; head of Canadian Hydrographic Service, 1920–36; in 1913 supervised the commissioning of the first vessel specifically designed for hydrographic work; 21 Sept.

BETTY BLOSSOM (ELIZABETH T. B. JOHNSON), New York, N.Y.; 48; botanist, writer, and former garden editor of *House and Garden*; 21 Sept.

REGINALD A. DALY, Cambridge, Mass.; 86; Sturgis Hooper professor emeritus of geology at Harvard University; author of eight books on the nature and structure of the earth; 19 Sept.

ALBERT G. DAVIS, Elizabeth, N.J.; 75; chemical engineer for the M.W. Kellogg Company, Jersey City; 20 Sept.

RALPH FULTON, Bound Brook, N.J.; 52; infrared spectroscopist; project leader in the Bakelite Company's Development Laboratories, Bound Brook; 27 Aug.

ROBERT LOWIE, Berkeley, Calif.; professor emeritus of anthropology at the University of California, Berkeley; specialist in the Indians of North and South America; 21 Sept.

ALBERT P. MATHEWS, Albany, N.Y.; 85; professor emeritus of biochemistry at the University of Cincinnati; made investigations in parthenogenesis and the nature of nerve impulses; 21 Sept.

MERRILL MOORE, Quincy, Mass.; 54; psychiatrist and neurologist; taught psychiatry at Harvard Medical School; specialist on the psychiatric aspects of alcoholism and suicide; 20 Sept.

WILLIS M. RAYTON, Hanover, N.H.; 48; professor of physics at Dartmouth College; project director for an ionospheric research program for the International Geophysical Year; 21 Sept.

FERRIS SMITH, Grand Rapids, Mich.; 73; pioneer in plastic surgery; author of *Reconstructive Surgery* and *Plastic and Reconstructive Surgery*; 18 Sept.

HENRY A. STRAUS, Waban, Mass.; 43; physicist at Lincoln Laboratory of Massachusetts Institute of Technology; aided development of the earliest microwave radar equipment; 21 Sept.

Reports

Oscillatory Membrane Currents of Squid Giant Axon under Voltage-Clamp

During the course of experiments designed to investigate the effects of various chemicals on the giant axon of the squid, *Loligo pealii*, it was found that the axon membrane often manifests an "oscillatory" character under the so-called voltage-clamp conditions. Since such a phenomenon has not been described by previous investigators who have studied the properties of the squid axon membrane under voltage-clamp (*1*), it seems worth while to report our observations on this phenomenon.

The experimental setup used for voltage-clamping was similar to the one employed previously (*2*) and is illustrated schematically in Fig. 1. The potential difference across the axon membrane was recorded with a unit-gain differential preamplifier (A_1). The output of A_1 was led also to one of the inputs of another differential amplifier (A_2) which had a gain of 2300. The latter amplifier was of the Tektronix 112 type modified to give an output impedance of about 250 ohms. The other input of A_2 was connected to a generator of rectangular voltage pulses. The output of A_2 was connected to the "current-electrode" in the axon through a variable resistance of 450 to 25,000 ohms (r) and a fixed resistance of 2 to 10 ohms (r'). There were blocking condensers between A_1 and A_2 and also between A_2 and r;—that is, negative feed-back was accomplished by condenser coupling. The switch between A_2 and r was operated manually, and the voltage across r', registered after differential amplification, gave the time course of the membrane current (I).

When the "membrane potential" of an axon in normal sea water was suddenly raised by 10 to 15 mv above the resting level and was maintained at this level for about 10 msec or more (21°C), it was frequently observed that a distinct inward (downward in records *A* and *B*, Fig. 1) surge of the membrane current started some time after the beginning of the clamping pulse. This first inward surge was followed by a reversal in the membrane current and then generally by another inward surge (Fig. 1, record *A*). Sometimes a rapid succession of six or more inward surges with first increasing and then decreasing amplitudes was encountered. When such a delayed oscillatory membrane current was observed, complete disappearance of the surges. a slight decrease in the intensity of the rectangular clamping pulse resulted in a A slight increase in the pulse intensity changed the oscillation into a rapidly damping type (Fig. 1, record *B*); a further increase altered the time course of the membrane current into the familiar type with a single peak of inward surge.

The oscillation of the membrane current under "voltage-clamp" did not appear to be a simple artifact. The imperfection of voltage-clamping might be regarded as a possible cause of such an artifact, but the following observations excluded this possibility: (i) the pattern of an oscillatory membrane current remained almost unchanged when the resistance r divided by the gain of A_2 was varied between 10 and 0.3 ohms; (ii) a compensation for the postulated series membrane resistance of about 10 ohm · cm² (*1*, p. 444) did not eliminate oscillation; and (iii) intracellular injection of tetraethylammonium chloride increased the time interval between individual surges.

The possibility that these repetitive inward surges might have originated in the portion of the axon membrane near the end of the current-electrode (where clamping is imperfect) was excluded by the following observation: the membrane current near the terminal portion of the current-electrode was recorded separately either by dividing the surrounding fluid medium with two partitions (*1*, *2*) or by the technique illustrated in Fig. 1 (top), in which two separate current-electrodes were used. In all cases, the repetitive inward surges were found to represent a greater current density in the middle portion of the clamped axon membrane than they did near its terminal portion.

Recently, oscillatory membrane currents under voltage-clamp were observed

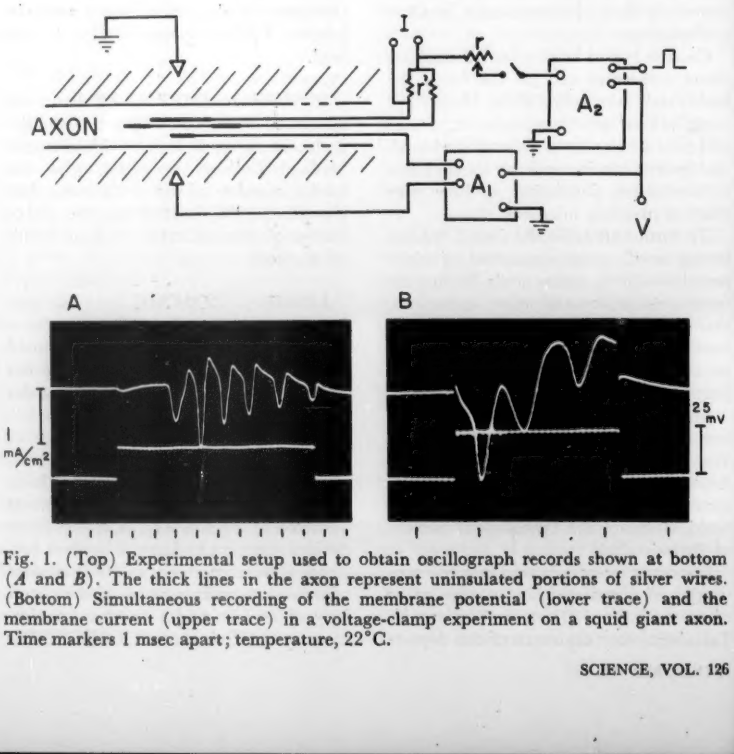

Fig. 1. (Top) Experimental setup used to obtain oscillograph records shown at bottom (*A* and *B*). The thick lines in the axon represent uninsulated portions of silver wires. (Bottom) Simultaneous recording of the membrane potential (lower trace) and the membrane current (upper trace) in a voltage-clamp experiment on a squid giant axon. Time markers 1 msec apart; temperature, 22°C.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

in the nodal membrane of the toad nerve fiber (*3*). The demonstration of this phenomenon in the normal squid axon suggests that the mechanism of production of action potential is very different from what has hitherto been generally accepted.

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9 July 1957

Role of Proline in Polypeptide Chain Configuration of Proteins

Optical rotation can be used to detect the presence of helical configurations of the polypeptide chains in proteins, to determine screw sense, and to estimate the extent of helical regions (*1*). Moffitt's theory (*1a*) of rotatory dispersion for helical macromolecules has been successfully applied to synthetic polypeptides (*2*) and to proteins (*2, 3*), and at the present time it may be applied empirically to estimate α-helix content. Globular proteins have been shown to have relatively low (*2*) and fibrous proteins to have relatively high (*3*) helix content. We have examined the amino acid composition of proteins which belong to the keratin-myosin-epidermin-fibrinogen class (KMEF proteins) to account for the wide variation in amount of α-helix present; in this report we demonstrate a striking correlation between proline content and extent of helical configuration.

Table 1 lists data obtained by proline determinations using the method of Troll and Lindsley (*4*). Helix content is based on rotatory dispersion measurements reported previously (*3*). We assume for this discussion that light meromyosin fraction I is 100-percent helical and that the helices have a single sense of twist. Fragmentation of myosin by tryptic digestion into light meromyosin and heavy meromyosin corresponds to a fractionation into one component relatively poor and one relatively rich in proline. Furthermore, the light meromyosin may be separated by ethanol into two fractions differing in proline content, one of which (light meromyosin fraction I) remains soluble after treatment with ethanol concentrations of 50 percent (volume by volume) or higher and represents about 25 percent of the intact myosin by weight (*5*). In each case, the higher the α-helix content, the lower the amount of proline present.

These results suggest that proline interferes with the formation of the α-helical configuration. By adopting a very simple model for the α-proteins consisting of helical and nonhelical regions, one may estimate the disordering effect of a single proline residue, assuming that the proline is distributed statistically. Table 1 shows that, on the average, each proline residue is associated with 15 to 20 residues (hence several helical turns) not participating in the right-handed α-helical configuration in aqueous solution. In nonaqueous solution, this effect may be decreased (*2*). These observations are supported by model building from which it is seen that the pyrrolidines do not fit well into a right-handed α-helix.

Available data on proteins other than the KMEF series show a generally similar correlation of proline and helix content. On the basis of dispersion studies (*2, 3*), one may take the specific rotation of native proteins in aqueous solution as inversely proportional to the α-helix content. Thus, a fully-coiled right-handed α-helix may be characterized by $[\alpha]_D \cong 0°$ (*2*) and nonhelical chains by $[\alpha]_D \cong -100°$ (*6*). Globular proteins have rotations $[\alpha]_D \cong -30°$ to $-60°$, corresponding to low helix content of about 30 to 40 percent (*2*). Tristram's compilations (*7*) show that these proteins contain from 3 to 8 percent proline, corresponding to values expected from the data given above on the KMEF series. Exceptions such as lysozyme, insulin, and avidin having less than 2 percent proline might be accounted for by sulfur or phosphorus cross-linkages which may interfere with α-helix formation. It should be noted that such cross-linkages, as well as side-chain interactions, may stabilize or disrupt helical configurations (*8*). Thus the KMEF proteins discussed above, having few if any sulfur cross-linkages (fibrinogen excepted), provide simpler systems for this correlation than do the "globular" proteins (*9*).

Proline content higher than about 8 percent would be expected to cause almost complete absence of the α-helix, provided that the proline residues do not exist as "blocks" in the polypeptide chain. The rotation of casein $[\alpha]_D \cong -100°$ (*10*) supports this idea, and rotatory dispersion data on casein and the prolamines should be of considerable interest (*11*). Collagen has an exceptionally high pyrrolidine content (about 25-percent), but rather than assuming a nonhelical configuration, the polypeptide chains in collagen comprise a cable of three left-handed helices, each similar to the poly-L-proline configuration (*12*). Solutions of collagen have rotations of the order of $[\alpha]_D \cong -350°$ (*13*), comparable to rotations found for poly-L-proline (*14*). Thus native proteins exhibit at least two kinds of helical configuration, depending on the amount of proline present, and the two classes of fibrous proteins, the collagen and KMEF, may be described respectively as pyrrolidine-rich and pyrrolidine-poor (*15*).

Table 1. Helix content and proline concentration of KMEF proteins.

Protein	Wt. % helix	Wt. % proline	No. of nonhelical residues per proline residue
Light meromyosin fraction I	100	0.22	∞
Tropomyosin	94	0.35	15
Paramyosin	91	0.21	36
Light meromyosin	74	0.97	23
Myosin	56	2.08	18
Heavy meromyosin	45	2.87	16
Fibrinogen	32	3.84	15

In summary, we suggest the generalization (i) that less than 3 percent proline distributed statistically in a chain permits more than 50 percent α-helix, (ii) that about 8 percent proline deforms the backbone into a random coil, and (iii) that very high proline may favor a poly-L-proline type helix.

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* This work was done during the tenure of an Established Investigatorship of the American Heart Association.

26 July 1957

Interaction of Stigmasterol and 2,4-Dinitrophenol in the Growth of Tetrahymena piriformis

Stigmasterol has been reported as a growth factor for several organisms, including the guinea pig (*1*), *Paramecium aurelia* (*2*), *Paramecium multimicronucleatum* (*3*), *and Stylonychia* (*4*). Extensive studies have been carried out on the mode of action of stigmasterol (antistiffness factor) in the metabolism of the guinea pig (*1*). These investigations revealed a marked reduction of anaerobic glycolysis in the tissues of deficient animals—a condition corrected by the addition of the antistiffness factor or adenosine triphosphate (ATP). Van Wagtendonk concluded that the steroid deficiency led to an altered phosphate metabolism, possibly a defect in the mechanism for the generation or transport of high-energy phosphate groupings. We believe that this hypothesis is strengthened by studies on the ciliated protozoan, *Tetrahymena piriformis*.

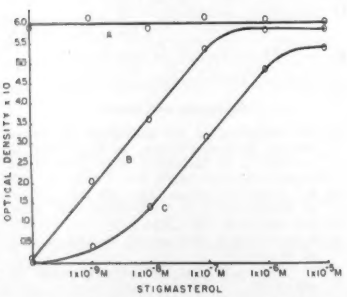

Fig. 1. Effect of DNP and stigmasterol on the growth of *Tetrahymena piriformis, W. Tetrahymena* were cultured in Kidder's medium A by means of the techniques and procedures developed by him for axenic culture (*11*). All points represent the optical density (×10) of cultures grown at 25°C for 96 hours, as measured in a Lumetron colorimeter at 650 mμ. Each experiment was repeated 5 times. Curve *A* represents stigmasterol; curve *B*, stigmasterol + DNP ($5 \times 10^{-5} M$); and curve *C*, stigmasterol + DNP ($1 \times 10^{-4} M$).

Tetrahymena has no exogenous nutritional steroid requirement but synthesizes a steroidlike compound, the configuration of which is not as yet known (*5*). However, the presence of this compound is capable of maintaining the growth of another protozoan, *Paramecium aurelia* (*6*), which has an absolute steroid growth requirement. The molecular configuration necessary for biological activity has been well established for *Paramecium,* and stigmasterol is one of the most effective sterols in promoting the growth of this organism (*7*). The *Tetrahymena* steroid is equivalent to stigmasterol in growth-promoting activity (*6*); thus, it seems possible that the *Tetrahymena* steroid is a member of the stigmasterol group.

In *Tetrahymena,* certain growth inhibitors, both steroidal and nonsteroidal in nature, induce a steroid requirement, which can be satisfied by stigmasterol (*6*)—further evidence of a possible relationship between the *Tetrahymena* steroid and stigmasterol.

Among the nonsteroid growth inhibitors, the most interesting is 2,4-dinitrophenol (DNP). The reversal of DNP growth inhibition in *Tetrahymena* in the presence of stigmasterol is shown in Fig. 1.

These growth studies indicate a close relationship between DNP and stigmasterol in the metabolism of *Tetrahymena.* The linearity of the reversal of DNP growth inhibition may indicate a competitive phenomenon. Further, since DNP is known to be an effective uncoupling agent of oxidation and phosphorylation (*8*) and an activator of adenosine triphosphatase (*9*), we believe that this study in *Tetrahymena* (*10*) not only indicates a mode of action of stigmasterol similar to that suggested for the guinea pig but greatly strengthens such an interpretation. While the studies with the antistiffness factor in the guinea pig indicated an influence of this compound on anaerobic glycolysis, this interpretation may be too limited and perhaps should be enlarged to include aerobic mechanisms. Further *in vivo* and *in vitro* experiments are being conducted to test this hypothesis.

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22 July 1957

Occurrence of trans Fatty Acids in Human Tissue

Except for small amounts of *trans* fatty acids in animal fats, dietary fats are composed of unsaturated fatty acids of *cis* geometric configuration. In 1928, Bertram (*1*) found small amounts of *trans* Δ 11-octadecenoic acid in ox, sheep, and butterfat; more recently (*2*), the presence of 4- to 11-percent *trans* fatty acids has been reported in deer, ox, and sheep depot fats. Although *trans* fatty acids do not seem to be normally present in nonruminants, they are found in the depot fats of rats which have been fed *trans* fatty acids (*3*).

Considerable amounts of *trans* fatty acids are formed during the commercial hydrogenation of vegetable oils (*4*); the shortenings and margarines which include these hydrogenated oils have been reported to contain as much as 23 to 42 percent of *trans* fatty acids (*5*). Furthermore, the isomers formed during selective hydrogenation are composed of a complex mixture of both geometric and positional isomers (*6*). The consumption of such fats would presumably lead to the deposition of *trans* fatty acids in depot fats.

In the present study, autopsy and biopsy material from 24 human subjects (*7*) was examined for the presence of *trans* fatty acids. The tissues were extracted in a Soxhlet apparatus for 24 hours with acetone and petroleum ether (Skellysolve F) as solvents, the extracts were dried over anhydrous sodium sulfate and filtered, and the solvent was removed under vacuum. The amounts of *trans* isomers in the lipid extracts were determined by the Jackson and Callen baseline method (*8*), in which a Beckman IR-2A spectrophotometer was used.

All the samples of tissue contained *trans* fatty acids. Adipose tissue contained from 2.4 to 12.2 percent, liver, 4.0 to 14.4 percent, heart, 4.6 to 9.3, percent, aortic tissue, 2.3 to 8.8 percent, and atheroma from subjects who had died of atherosclerosis, 2.3 to 8.8 percent of *trans* fatty acids. It has been pointed out that *trans* linoleic acid does not function efficiently as an essential fatty acid (*9*), although *trans* fatty acids seem to be metabolized (*10*). Furthermore, it has recently been reported that *trans* crotonyl CoA is the preferred substrate for the unsaturated acyl CoA hydrase from beef liver (*11*). Presumably, therefore, long-chain *trans* fatty acids may be metabolized as readily as the *cis* fatty acids. However, in view of the current controversy on the relationship of "hard" vs. "soft" fats (*12*), it would seem necessary to determine what effect, if any, *trans* fatty acids have on the normal metabolic process.

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8 August 1957

Uptake of Calcium-45 and Strontium-90 from Water by Fresh-Water Fishes

In conjunction with our studies concerning the uptake and accumulation of calcium-45 and strontium-90 into the body and tissues of the guppy (*Lebistes*) (*1, 2*), I observed that zebra fish (*Danio*) and white cloud mountain fish (*Tanichthys*) take up both isotopes from water in a similar manner. It is well known that strontium, when fed or injected into animals, accumulates in bone and tissues of high calcium content and appears to be related to the metabolism of calcium. However, Alexander *et al.* (*3*), Norris and Kisieleski (*4*), and Comar *et al.* (*5*) have shown that small laboratory mammals discriminate against strontium relative to calcium. More recently, Boroughs *et al.* (*6*) have shown that marine fishes discriminate against strontium relative to calcium, when strontium-89 is added to the sea water in which they swim. The present report (*7*) gives data comparing the uptake of calcium-45 and strontium-90 by three species of fresh-water fishes.

Table 1. Rate of uptake of calcium-45 from water by various fishes.

Species	Body calcium ± S.D.* (*A*) (percentage of body wt.)	Rate of uptake† ± S.D.* (*B*)	Ratio *B/A*
Guppy	1.14 ± 0.09 (23)‡	0.81 ± 0.01 (38)§	0.71
Zebra fish	1.13 ± 0.12 (22)‡	0.84 ± 0.02 (27)§	0.74
White cloud mountain fish	1.01 ± 0.13 (28)‡	0.78 ± 0.02 (27)§	0.77

* Standard deviation = $(\Sigma d^2/n)^{1/2}$.
† $\frac{\text{Log count/min/100 mg/day}}{\text{Log water activity count/min ml}}$ The water contained 10^5 counts/min ml.
‡ The number in parentheses indicates average values obtained on pools of two to three fishes.
§ The number in parentheses indicates number of fishes derived from experiments shown in Fig. 1.

Adult fishes, obtained from commercial sources, were of mixed sexes for the zebra and white cloud mountain fish, but the guppies were all sexually mature males. The guppies and white cloud mountain fishes averaged about 125 mg, while the zebra fish were each about 225 mg in weight. The experimental design and the assay of radioactivity have previously been reported in detail (*1, 2*). The samples were counted to within a 5-percent statistical error with a windowless gas flow counter, with counting efficiencies for strontium-90 (*8*) and calcium-45 of 1.5×10^{10} and 1.0×10^{9} count/min mc, respectively. Self-absorption and decay corrections have been made when necessary. Calcium analyses were made by permanganate titration following precipitation of the oxalate, as has been previously described (*9*).

The uptake of calcium-45 and strontium-90 from the water in which the fishes swim is linear with respect to time for the three species at all water isotope activities studied. Representative data of some of our experiments with both isotopes are shown in Figs. 1 and 2. The linear uptake of these isotopes may be interpreted to indicate the continual formation or exchange of the mineral component of bone, with sequestration of the isotopes into bone matrix.

Previous investigators have indicated that the rate of uptake of strontium-89 from water by goldfish (*10*) and marine *Tilapia* (*11*) decreased with time. An explanation for the discrepancy between my results and those of other investigators is not readily apparent. However, at the isotopic water activities used in the present work, it was found that strontium-90 activity in water could not be maintained at a constant level but began to decrease appreciably when the experiments were extended beyond 20 days. For this reason, experiments longer than 14 to 18 days were not performed. It is presumed that excess accumulation of metabolic products and feces may have removed some of the strontium-90 from solution by adsorption. Similar difficulties in keeping strontium-89 in

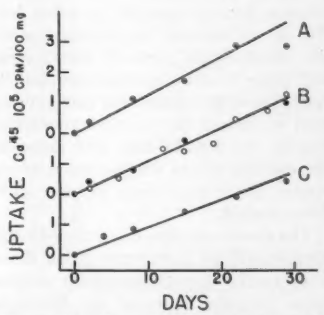

Fig. 1. Uptake of calcium-45 by fresh-water fishes versus days in water containing about 10^5 count/min ml. (*A*) Zebra fish; (*B*) guppy (two experiments); (*C*) white cloud mountain fish. Each point represents an average of two to six fish.

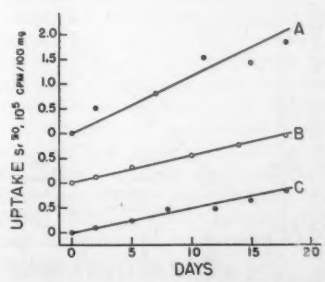

Fig. 2. Uptake of strontium-90 by fresh-water fishes versus days in water containing about 10^5 count/min ml. (*A*) Zebra fish; (*B*) guppy; and (*C*) white cloud mountain fish.

solution were encountered by Prosser *et al.* (*10*). The calcium-45 activity of the water could be maintained at constant levels for at least 30 days, as has been previously described (*1*).

As we have previously shown for guppies with calcium-45, the relationship between uptake of bone-seeking isotopes and water activity is adequately described by a logarithmic function (*1*). The same relationship holds true for both nuclides, strontium-90 and calcium-45, in all three species of fishes, as is shown in Fig. 3. The line of regression, calculated by the method of least squares for the experimental data, is best described by the equation $y = 0.13x^{0.97}$, which compares favorably with the equation $y = 0.19x^{0.92}$ obtained with calcium-45 and guppies (*1*).

That a relationship exists between calcium-45 uptake from water and the concentration of body calcium and body weight is shown in Table 1. It is apparent that the rates of uptake of calcium-45 from water by the three species of fishes do not differ significantly when the data are expressed in terms of either body weight or body calcium concentration. Although the white cloud mountain fish appear to contain less calcium than do guppies or zebra fish, this is of doubtful significance, since the white clouds were of mixed sexes and some of the females were full of eggs. The eggs contain less calcium and tend to reduce the calcium concentration of the female fish, and therefore the calcium values for the entire group appear lower than those for the other fishes studied.

The similar uptakes of calcium-45 and strontium-90 by fresh-water fishes differ from similar experiments with marine fishes recently indicated by Boroughs *et al.* (*6*). These authors found that marine *Tilapia* discriminate against strontium relative to calcium, as has been shown for mammals by various investigators. The apparent lack of discrimination of strontium-90 by fresh-water fishes probably reflects differences between fresh-water and marine fishes in absorption of the isotope by the gills, skin, and intestinal tract (*12*) rather than fundamental alterations in the metabolism of mineral elements of bone.

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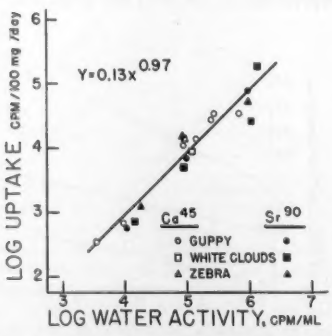

Fig. 3. Rate of uptake of calcium-45 and strontium-90 by fresh-water fishes versus activity of the water in which they swim. Each point represents data from six to 30 fish.

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27 May 1957

Effects of Intraventricular Injections of Streptolysin O in Unanesthetized Cats

The technique of intraventricular injection in the unanesthetized cat (*1*) makes it possible to study the direct actions of drugs in the brain (*2*). This technique also provides an opportunity to study the corresponding actions of bacterial toxins. Because we have studied in our laboratory the pharmacodynamic actions of some bacterial toxins (streptolysin O, *Shigella shigae* toxin, and *Salmonella typhi* abd. endotoxin), including some of their actions on the nervous system after parenteral injection (*3*), this new approach seemed interesting.

We have shown that streptolysin O causes an alteration of the excitability of chemoreceptors and, under the conditions of previous sensitization, may cause deep circulatory disturbances of a reflex character (*4*). Even small doses inhibit positive conditioned reflexes (*5*). Local application of the toxin impairs the conductivity of the sciatic nerve (*6*). All observed phenomena are of a non-specific character, for they may also be caused by the other toxins studied, and immunization with one toxin causes an adaptation to others that are antigenically unrelated (streptolysin O, *Salmonella typhi* abd. endotoxin).

For the experiments described in this report (*7*) we used cats with inserted Feldberg-Sherwood cannulas. In unanesthetized cats, 0.1 to 0.5 ml of streptolysin O (*8*) was injected through the cannula in the left lateral ventricle. Its preparation has been described previously (*9*). It contained 140 hemolytic units per milliliter, and after intravenous administration its LD_{50} for mice was 0.3 ml/20 g. For control purposes, 0.5 ml of Kalbak bouillon was injected in the same way into another group of cats. To five unanesthetized animals, an intravenous injection of 0.5 to 2.0 ml of streptolysin O was given.

The intraventricular injection of streptolysin O causes, in the cat, a typical response. Within 1 minute after the injection, most of the cats start miaowing in a plaintive, monotonous way; this lasts for several minutes. This is practically the first sign. In 50 percent of the animals, profound salivation, preceded by mouth licking, starts 1 to 4 minutes after injection. This is sometimes accompanied by a marked increase in respiration rate. Retching, vomiting, and defecation occur only in a minority of the animals.

In the second minute after injection, changes in motility begin. The cat claws, stretches, and flexes its forelegs, first the right one, then the left. The phenomenon is very typical and appears in varying degrees of intensity during the whole time of abnormal behavior of the cat. Later, tonic movements of the forelegs begin. These are less marked in the hindlegs. In some cats, circling movements are present. The hindquarters are raised and practically motionless, whereas the cat circles slowly around on its forelegs. Sometimes the cat reclines on its side for several minutes. The head

Fig. 1. Cat, age 3 years, 5 kg, male, 14 minutes after injection of 0.5 ml of streptolysin O in the left lateral ventricle. The cat is in a typical position; note the clawing of the right foreleg, circling movements of the head, the elevated tail, and the very low tone of the back.

is raised and makes circling movements, and the forelegs are stretched (Fig. 1).

Sometimes the cat makes beating movements with its forelegs, indicating alternate increase and decrease in muscle tone. Especially, the tone of the back may be very low. About 30 percent of the animals have a marked nystagmus. The cat does not answer to calls for several hours. It is able to walk, but its movements are inaccurate, it falls easily, and uncoordinated movements occur. After 1 to 2 hours the cat calms down, but the clawing movements persist for days. Some cats recover completely after several days. Others fall into a state of complete inertia. They do not clean their fur, and they have sore mouths and sore eyes. They may do several steps in a strange atactic way, and they may take food. Within 8 to 10 days they die. Control injections with Ringer solution have no effect. Injections with Kalbak bouillon sometimes cause, for the first 2 to 3 minutes, light clawing movements; after this the animals are normal. With *Shigella shigae* toxin and with staphylolysin (*10*), the picture under the same experimental conditions is entirely different. Therefore, the picture seems to be typical for streptolysin O. Some of its patterns remind us of a choreic state. Since Sydenham's chorea is related frequently to previous streptococcal infection (*11*), our findings encourage us to undertake further studies.

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29 July 1957

Effect of Gibberellic Acid and Indoleacetic Acid on Growth of Excised Fruit Tissue

Gibberellic acid, a metabolic product of certain strains of *Fusarium moniliforme*, is capable of stimulating growth in many plants (*1*). Its effect has been attributed basically to a promotion of cell elongation (*1*), and it has recently been shown to promote cell division (*2*). Auxins, both natural and synthetic, have been found to stimulate callus formation in a wide variety of plant tissues (*3*). Cellular proliferation of excised mature pericarp tissue has been demonstrated in the avocado (*4*). The purpose of this report (*5*) is to show that gibberellic acid is capable of stimulating callus formation in excised fruit tissue cultures and that this effect is greater if indoleacetic acid is supplied simultaneously.

The tissues used in this experiment were obtained from the mesocarp of a mature citron (*Citrus medica*) by slicing the fruit transversely and removing round plugs of tissue with a cork borer. These tissue explants were weighed and planted individually under aseptic conditions on agar medium formulated by Nitsch (*6*), which was modified by replacing yeast extract with a mixture of thiamine, pyridoxine, nicotinic acid, and glycine. The tissue explants, each approximately 2 mm thick and 8 mm in diameter, had an average weight of 115 mg. Various amounts of gibberellic acid (*7*) and indoleacetic acid were added to the base medium so that the final concentrations of 0, 0.5, 5.0, 25, 50, and 100 ppm of gibberellic acid and 0, 0.1, and 1.0 ppm of indoleacetic acid were obtained. This gave a total of 18 combinations. The final medium was dispensed at 10 ml per 6-dram screw-top vial and autoclaved at 15 pounds pressure for 20 minutes. At least eight cultures were used in each combination except for the two highest gibberellic acid concentrations, each of which consisted of five cultures.

From Fig. 1 it is apparent that both indoleacetic acid and gibberellic acid stimulate callus formation. Microscopic observations at the end of eight weeks indicated that most of the original cells had died. The callus tissue, however, was fully alive and consisted of many relatively small, thin-walled cells. These anatomical observations suggest that any increase in weight must be due to an increase in cell number.

The curves in Fig. 2 represent the change in fresh weight of each tissue explant as the gibberellic acid concentration increased. In the absence of indoleacetic acid, 5 ppm of gibberellic acid caused maximum weight increase, while the higher and lower concentrations used were much less effective. In the presence of indoleacetic acid, 0.5 ppm of gibberellic acid caused a marked increase in weight, and the stimulatory effect of gibberellic acid increased up to a concentration of 25 ppm. Only at 50 ppm and 100 ppm of gibberellic acid was there a decrease in the stimulatory response.

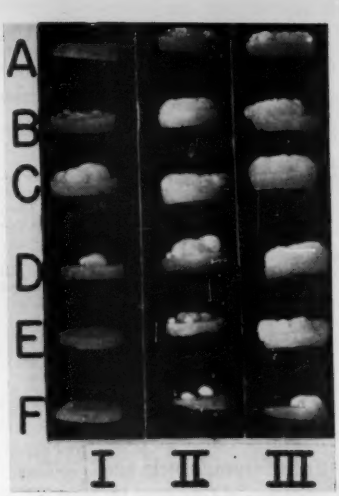

Fig. 1. Side view of citron fruit explants grown *in vitro*: (vertical rows) concentrations of indoleacetic acid (I, 0; II, 0.1; and III, 1.0 ppm); (horizontal rows) concentration of gibberellic acid (A, 0; B, 0.5; C, 5.0; D, 25; E, 50; F, 100 ppm).

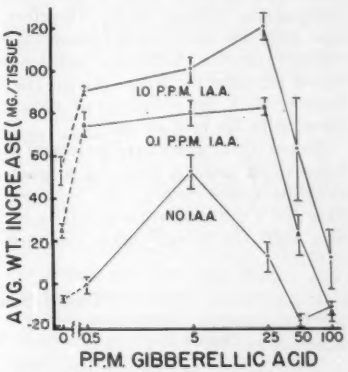

Fig. 2. Average increase in fresh weight of excised citron tissue in relation to gibberellic acid and indoleacetic acid. Gibberellic acid concentrations plotted on logarithmic scale.

This experiment suggests that gibberellic acid and indoleacetic acid stimulate callus formation in excised citron tissue and that the tissues respond to a wider range of gibberellic acid when they are grown in the presence of exogenous indoleacetic acid.

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19 July 1957

Vitamin A-Carotene Deficiency Affects Serum Protein and Utilization of Carotene by Steers

A close relationship between serum proteins and vitamin A-carotene utilization or tissue storage, or both, has been shown (*1*, *2*). Limited data (*3*) indicate that the cow's carotene requirement is markedly increased after a prolonged suboptimum carotene intake. Therefore, this study was undertaken to determine whether vitamin A-carotene deficiency would influence the serum protein fractions or alter the utilization of dietary carotene by the beef animal.

Eleven 800-lb steers were pretreated as follows: six animals were fed a grain-straw diet (carotene-free), and five steers were fed a grain-dehydrated alfalfa ration, until the former group exhibited vitamin-A deficiency symptoms (about 120 days). All animals were then fed a carotene-free diet for the 14-day experimental period. Pure carotene (10 percent alpha and 90 percent beta in an aqueous solution with Tween 80, *4*) was administered by means of a stomach tube to all steers (15 mg of carotene/100 lb of body weight) on alternate days for the first 10 days of the experimental period.

Table 1 shows the plasma vitamin A and carotene and the serum protein fractions (*5*) of the normal and deficient animals before and after carotene administration. As expected, the plasma vitamin A and carotene increased after administration of carotene to the deficient steers. The normal steers exhibited a decreased plasma level of both carotene and vitamin A, the latter changing only slightly. Prior to carotene treatment, the percentage of beta globulin in the serum of the deficient steers was significantly higher than that in the normal steers. In the pretreated, vitamin A-deficient animals, serum albumin increased (average, 5.6 percent) while alpha and beta globulin decreased significantly (3 and 5.8 percent, respectively) after the 10 days of carotene administration. Although the remaining fractions differ, none were statistically significant. The total serum protein was not affected by either vitamin A deficiency or carotene administration. No correlation was found between the change in blood vitamin A and carotene and the change that occurred among the serum proteins. Although work with human serum (*1*) has shown that beta globulin binds about 50 percent of the blood carotene, the beta globulin was markedly greater in the carotene-deficient steers in this study.

All animals were subjected to liver biopsy (*6*) at 0 and 14 days of the experimental period. The samples were analyzed for vitamin A and carotene (*7*). Table 1 shows the liver storage of vitamin A and carotene, as affected by pretreatment, before and after oral administration of carotene. The results of the liver analyses were extremely consistent within animals with the same pretreatment. Under the conditions of this experiment, there was no increase in the liver carotene content of the deficient or normal steers as a result of carotene administration. However, there was a large increase in the liver storage of vitamin A in the normal steers following carotene administration. There was no increase in the liver vitamin A content of the carotene-deficient animals. This marked difference in vitamin A deposition in the liver may suggest a lack of conversion of carotene to vitamin A in the deficient steers. However, the fact that plasma vitamin A increased in the deficient animals does not appear to uphold this hypothesis. On the other hand, these results may indicate extrahepatic utilization or storage of the vitamin A formed in the deficient animals, or both. This explanation is supported by results with rats (*8*), in which a higher dosage of vitamin A was required for liver deposition in deficient rats than was required to alter the blood level of the vitamin (*9*).

Table 1. Summary of results.

Day	Plasma		Serum*				Liver	
	Vitamin A (μg/100 ml)	Carotene (μg/100 ml)	Albumin (%)	α-Globulin (%)	β-Globulin (%)	γ-Globulin (%)	Vitamin A (μg/g)	Carotene (μg/g)
			Normal steers (average of five steers)					
0	65	240	41.2	17.6	16.6	24.6	23.41	7.36
2	60	263						
4	42	222						
6	48	232						
8	52	202						
10	53	150	44.5	15.4	15.7	24.4		
14							38.55	6.73
			Deficient steers (average of six steers)					
0	2	0	39.4	17.6	21.7	21.3	1.57	2.21
2	10	11						
4	26	22						
6	26	43						
8	28	51						
10	29	28	45.0	14.6	15.9	24.5		
14							0.58	0.54

* Each figure represents an average obtained from figures for four steers.

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10 June 1957

Book Reviews

The Physiology of the Pituitary Glands of Fishes. Grace E. Pickford and James W. Atz. New York Zoological Society, New York, 1957. xxiii + 613 pp. $6.

The Physiology of the Pituitary Gland of Fishes is a book that students of fish endocrinology have been hoping for. Heretofore, the literature of this field has been scattered through a wide variety of journals and languages. Now, for the first time, all significant contributions to the knowledge of the functioning of the pituitary gland of fishes, including its morphology and relationships to the target organs of the endocrine system, have been brought together in a comprehensive and orderly manner.

The book consists of three main divisions: text, tables, and bibliography. The introduction and six of the seven chapters of the text are written by Grace E. Pickford; the last and longest section, by James W. Atz. In the introductory chapter, an attempt is made to bring order out of the chaos of the terminology used in describing the several parts of the fish pituitary, which differs considerably from the mammalian gland. While the proposed terminology may not be generally acceptable or final, it does indicate clearly the different regions of the fish pituitary and should be helpful to workers in this field. To provide a general background for discussion of the physiology of the fish pituitary, a succinct and well-balanced account of the hormones and cell types of the mammal pituitary is presented.

Each of the succeeding sections, which deal with the different pituitary hormones and their effects, begins with a statement of what is known concerning the particular hormone in mammals, birds, and amphibians. Then the several classes, orders, and suborders of fishes are taken up. The value of separating groups and species of fishes is brought out, particularly in the classification of their chromatophore reactions. It is doubtful whether any zoological literature is more confusing and contradictory than that dealing with fishes' color responses to pituitary hormones and other influences. By means of careful analyses of procedures and the grouping of types of response in different fishes (given in detail in the accompanying tables), Pickford has managed to derive a reasonable working classification in a field which is still far from being completely explored. This is the best discussion that has been written on the subject and constitutes a real contribution.

Limitations of space preclude comments on the excellent presentation of the hormones of the neurohypophysis, growth hormone, corticotropin, and the adrenal. Treatment of the thyroid and thyrotropin is comprehensive and brings out many similarities to, and some differences from, the mammalian thyroid functioning. In part VII, the relation of the pituitary to reproduction in fishes, Atz has with great success assembled, analyzed, and classified the abundant and diversified literature on this subject. This chapter is of especial value in that a number of Russian and Brazilian contributions, previously inaccessible to the general reader, are here made available. Since most of the work on hormonal stimulation of spawning in fishes has been done in these two countries, knowledge of their progress in the field is obviously important.

One of the outstanding merits of the book is the section of some 200 pages of tables. The tabulated data, presented clearly and in sufficient detail by the authors, adds greatly to the value of the text. In addition, there are 25 summarizing text tables. The bibliography is inclusive and brings the literature up to the middle of 1956. The index is unusually complete. This is a remarkably scholarly and valuable piece of work, which adds new significance to the study of fish endocrines as a fertile field in the domain of general vertebrate endocrinology.

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Advances in Protein Chemistry. vol. XI. M. L. Anson, K. Bailey, and J. T. Edsall, Eds. Academic Press, New York, 1956. 591 pp. Illus. + cumulative index, vols. VI–X. $12.

The 11th volume in this valuable series maintains the consistently high standards of the earlier volumes with a series of six articles which range over a good part of present-day protein chemistry. The articles and their authors are as follows: "Protein structure in relation to function and biosynthesis," by C. B. Anfinsen and R. R. Redfield; "Hormones of the anterior pituitary gland: part 1, Growth and adrenocorticotropic hormones," by C. H. Li; "Column chromatography of peptides and proteins," by S. Moore and W. H. Stein; "Countercurrent distribution in protein chemistry," by P. von Tavel and R. Signer; "Complex formation between metallic cations and proteins, peptides, and amino acids," by F. N. R. Gurd and P. E. Wilcox; and "Measurement and interpretation of diffusion coefficients of proteins," by L. J. Gosting.

The types of reviews included in the present volume tend to reflect the spectacular progress of recent years in the study of protein structure and in the attempts to understand the functional properties of these complex molecules in terms of their structure. The articles by Anfinsen and Redfield and by Li deal largely with this problem. Likewise, the discussion of column chromatography and countercurrent distribution reflects the important advances in methodology which have made possible such rapid progress. These methods have been invaluable, both for isolation of pure proteins and for their partial hydrolysis products, the peptides. Both types of methods have come to be among the most generally used in protein chemistry in a relatively short time.

The specific interactions of proteins are obviously of great importance for understanding the behavior and function of these large molecules. The present review by Gurd and Wilcox summarizes current theory of interaction of metallic cations with proteins and discusses the presently available information.

Hand-in-hand with progress in understanding the chemical structure of proteins has been the development and use of physical methods which have permitted studies of these large molecules. Gosting provides a comprehensive discussion of the theory and application of diffusion measurements. Technical progress in this field has been spectacular, owing largely to the development of interferometric optical systems for measuring refractive index gradients. This has provided a tenfold increase in the accuracy by which diffusion constants can be estimated. As a result, such measurements are now among the most precise available for studying the physical properties of proteins.

It is of interest to all who must keep abreast of rapidly developing fields to contrast the two types of review volumes which are published periodically—those which summarize information in certain fields annually and those which review certain topics occasionally. *Advances in*

Protein Chemistry falls into the latter class. The present volume contains only six articles, which occupy more than 550 pages. For a comprehensive view of the whole field of protein chemistry, it is necessary to peruse the entire series of volumes. Nevertheless, the current volume is required reading for all who are interested in protein chemistry. As in the earlier volumes, the articles are well written, and the editing has been done with great care.

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The Proceedings of the Third International Conference on Electron Microscopy, London, 1954. V. E. Cosslett, chair., editorial committee; R. Ross, General Ed. Royal Microscopical Society, London, 1956. xv + 705 pp. Illus. + plates. $15.

This impressive volume represents the text of papers contributed to, and the discussion offered at, the third international Conference on Electron Microscopy, the previous meetings being those at Delft, in 1948, and Paris, in 1950. The book is a rich source of information on many aspects of electron microscopy and related fields of endeavor; it deserves a place on the shelf of every professional electron microscopist.

The contributions, 158 in all, including three introductory survey papers, although of rather unequal quality, contain many papers of high quality. A prime advantage of a volume such as this is that it brings together, in conveniently accessible and brief form, a wealth of information on topics such as electron optics, specimen preparation, microtomy, the action of electrons on the specimen, and the attainment of high resolution, which in this era of very rapid expansion of the field is only to be gleaned otherwise from a rapidly increasing and formidably diverse list of publications and, moreover, is not to be found in the textbooks. For those involved in pursuits less orthodox than transmission microscopy, there are the sections on ion microscopes, x-ray microscopes, and emission and reflection electron microscopy. In addition, there are sections devoted to applications—for example, those concerned with biological fine structure, metallurgy, and industrial and chemical applications.

The format of the volume and the quality of the reproductions are excellent. The classification of the contributions under a wide variety of headings assists the reader in locating information of interest, but it is to be regretted that no author or subject index, however brief, was included.

A further cause for regret, and a more serious one, is the excessively long time interval between the meeting itself and the appearance of the *Proceedings*. Such a time lag is particularly undesirable if results presented to the conference will not become available to those interested until and unless they are published elsewhere in addition. The spectacularly rapid growth of the field of electron microscopy in recent years makes it more and more important that the proceedings of such conferences be published promptly, so that results of importance are circulated in as short a time as possible. The editorial committee and the Royal Microscopical Society are, in the present case, to be congratulated on carrying out a fine and very thorough job, even though they considerably overstepped their original aim of publication within 12 months of the conference. However, the need for more stringent measures is clearly indicated for future conferences of this character. In the present volume, the discussions following papers or groups of papers appear to contribute but a small fraction of the useful information contained in the book, yet they must surely have demanded an inordinate amount of editorial time as well as entailing considerable delay in publication. Publication of such discussions could probably be eliminated without detracting too seriously from the value of such a volume. It must seriously be considered whether rapidity of publication of such proceedings is not more important than detailed reporting, especially of discussions which are often of a sporadic nature, uneven in quality, and of questionable bearing on the subject under discussion.

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Quantum Mechanics. H. A. Kramers. Translated by D. ter Haar. North-Holland, Amsterdam; Interscience, New York, 1957. xvi + 496 pp. $12.50. (pt. 1, 5 chapters, also published separately as *The Foundations of Quantum Theory,* xv + 228 pp. $6.50.)

"When I was asked whether I would be willing to prepare a translation of Kramers' monograph, and thus complete an English edition of all his published works, I agreed for several reasons, even if it meant the hazardous task of translating from one foreign language into another. The main reason was that I felt that this book still represents the best available exposition of quantum theory and that the English speaking world was the poorer for not having it readily available. Also, in this book, as much as in some of his papers, Kramers showed some delightfully elegant methods which might otherwise be lost to the physics world in general."

With these words the translator's preface to *Quantum Mechanics* starts. I would like to add at once that this admirable translation, of which the language in parts is smoother than that of the original, is a good book for the intelligent, self-taught, theoretical student who wants to get a thorough understanding of many of the principles of modern quantum theory, in particular if he plans to continue his studies later by more specialized books. Some students may consider it a drawback that there are no assigned problems and that the number of applications of the theory worked out in the text itself is relatively small. An instructor using Kramers' book as a textbook can, of course, provide his class with his own choice of problems picked from other textbooks. For the students, however, working out in detail some mathematical derivations which the book gives merely in the form of an outline may be an assignment more useful than some of the useless "exercises for the sake of an exercise" found in certain other introductory textbooks. By not burdening the student with such useless material, this book finds space for a thorough discussion of a number of important aspects of wave mechanics and of matrix mechanics which in many other textbooks are neglected.

The book is somewhat mathematical in character, although the author purposely avoids mathematical rigor (see the preface on page v !), but at no place are theoretical results compared with any illustrative experimental data. The book consists of two parts, of which the first is available as a separate book under the title *The Foundations of Quantum Theory*. Part I deals with nonrelativistic wave mechanics of electrons and does not discuss spin, Pauli's exclusion principle, or electromagnetic radiation. It may be sufficient as a textbook for an introductory course on wave mechanics. Since part II is available only together with part I, in a single volume, students who need quantum theory for their later work, or who may later want to find out at least for themselves about spin, exclusion principle, Bohr's quantum jumps, and photons, would do well to buy at once the complete *Quantum Mechanics,* containing both parts.

Part I starts out with a discussion of de Broglie waves and their superposition and the uncertainty relations. Among the further topics treated we note thorough discussions of eigenvalue problems; proper and improper eigenfunctions; the approximately classical motion of wave packets for interacting particles; the interpretation of the state vector; transformation theory; Dirac's bra-and-ket nota-

tion; time-dependent quantum operators; a particularly elegant discussion of spherical harmonics and the angular momentum; the Schrödinger theory of the hydrogen atom, including the eigenfunctions for the continuous spectrum for unbound electrons in a Coulomb field; perturbation theory of stationary states, also for higher-order approximations and for degenerate eigenvalues; variational methods for approximating energy levels and wave functions; a simple account of time-dependent perturbation calculus and the theories of scattering and transition probabilities; the quantum-mechanical adiabatic theorem for perturbations switched on slowly; and, finally, a brief introduction to the theory of the natural line width.

Topics which one might desire in an introduction of this kind but which are not discussed, or are insufficiently discussed, in Kramers' book are the distinction between pure-case and mixed-case assemblages and the impossibility of describing the latter by a single state vector; the subjective character of the state vector and its "reduction" after observation of the outcome of an interaction; Bohr's analysis of possible experiments for showing that wave-mechanical uncertainty relations do not show an incompleteness of the theory but describe experimental reality; the electron wave function in periodic potentials, Brillouin zones, and so forth; the application of the W.K.B. method for evaluating radial wave functions; virtual energy levels in a continuous spectrum; the phase-shift representation of scattering as an application of time-independent perturbation theory. Such fundamental principles as that the probability density of electrons is $\psi^*\psi$, and that $h\nu$ equals the total and not just the kinetic energy, are postulated without even an attempt at explanation.

Part II starts with Uhlenbeck and Goudsmit's theory of the electron spin and, through a classical and a semiclassical discussion of the spin and of the Thomas factor, then proceeds to the nonrelativistic, as well as the relativistic, theory of spinors, represented in a very elegant, clear, and concise form, which in turn leads to Dirac's equations in a manner far more heuristic and natural than Dirac's own axiomatic derivation, which is mentioned too. After the relativistic four-component wave functions for free electrons of given momentum, Kramers derives Pauli's theory of the spinning electron as an approximation to the rigorous theory for slow electrons and arrives at Breit's formula for the magnetic interaction between bound electrons. The Dirac theory of the hydrogen atom is concluded by a discussion of the wave functions of the continuous spectra for $|E| > m_0c^2$.

The next chapter deals with the exclusion principle and with "second quantization" as a formalism equivalent to describing the state vector by means of Slater determinants. Although the second-quantized wave function is introduced and its usefulness is shown, Fock's elegant theory of 1932, of second quantization in configuration space, is not presented in full. Instead, use is made of creation and annihilation operators and of a transformation from the configuration space to the occupation number representation of the state vector.

Next discussed are singlet and triplet states, exchange integrals, and the multiplet situations in the N-electron problem. Here the eigenvalues of the angular momentum are shown to follow algebraically from their commutation relations. Then, the spin functions in multiplet situations are treated, and the group-theoretical reduction of the space functions of various symmetry types is executed without the use of group theory by Kramers' elegant "symbolic method." The chapter is concluded by a discussion of Russell-Saunders coupling and by an introduction to the theory of homopolar chemical bonds.

Surprisingly *not* discussed in this part of the book are the wave-mechanical explanation of such features of atomic theory as the vector model, Hund's rules, and Stark effect, the periodic system of atoms, and the Thomas-Fermi statistical model. Clebsch-Gordan coefficients are not mentioned.

The last chapter exhibits the fundamentals of quantum electrodynamics; its study is seriously recommended to any student planning to read Heitler's famous *Theory of Radiation*. Kramers starts from the classical theory of radiation and shows how already before the development of quantum electrodynamics, by Heisenberg's interpretation of matrix elements of the "observable" electric polarization, it was possible to derive formulas for Einstein's transition probabilities B and A for absorption and for emission. Kramers also discusses the interaction of radiation with the "spin current." A brief account is given of multipole radiation, and the semiclassical treatment thus far given is justified by Bohr's correspondence principle and the W.K.B. method.

Kramers then discusses the quantization of the radiation field in a vacuum and the transverse nature of photons. The theory becomes particularly elegant where circularly, instead of linearly, polarized light waves are considered. Kramers' discussion of the interaction of photons with electrons is unique and forms the historical background to Schwinger's later relativistic theory of mass renormalization. In Kramers' treatment, the mass is always the experimental mass, and the field acting on an electron excludes the so-called "eigenfield" (proper field) of the electron. It is shown that in a secular approximation —neglecting periodic terms which have no effect over long-time intervals—the interacting fields then can be described by the canonical formalism of Dirac's radiation theory. The book is concluded by a few applications of quantum electrodynamics, absorption and emission of photons, natural line width, Rayleigh scattering, Smekal-Raman effect, Compton effect, semiclassical scattering theory, coherent scattering, and dispersion.

Few printing errors were found. An occasional error in the original has tacitly been corrected in the translation, some obscure statements of the original have been elucidated, and some newer literature references have been added. This is a fine translation of a remarkable book, which is recommended to every serious student of theoretical physics.

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Mitochondria and Other Cytoplasmic Inclusions. No. X. Symposia of the Society for Experimental Biology. Academic Press, New York, 1957. 198 pp. Illus. + plates. $9.50.

The tenth volume of the symposia series of the British Society for Experimental Biology, comprised of papers read at a symposium held at Oxford, September 1955, is highly satisfactory. It begins with J. R. Baker's almost devastating attack on the Golgi artefact and ends with Randall's interesting observations on the electron microscopy of *Spirostemum*. All of the 11 papers in the symposium deal with mitochondria and other cytoplasmic inclusions. Two chapters in defense of the Golgi apparatus help to complete the book.

Particularly clear illustrations of living cells are found in the analysis of phase-contrast and interference microscopy by Barer and Joseph. These authors lay stress on rotation phenomena of mitochondria around the nucleus and are at pains to reconcile their data with those of Chèvremont and Frederic, but, even with their biochemical findings, there is much to be desired. Excellent photomicrographs, with studies on vacuoles and neutral-red-staining bodies in small amebocytes, are offered by G. N. C. Crawford. Perhaps some readers may be disturbed by his exact disclosure of discrepancies brought out in all microscopic structures by the addition of fixing agents.

In another direction, interesting cytochemical problems are explored. Relationships between enzymatic activity and

particles obtained through differential centrifugation appear in three chapters, while another section is devoted to similar particles in plant cells. It is apparent that problems like those of the biochemistry of sarcosomes, Golgi bodies, and rat liver particles need considerably more careful and exact research. The reader may here see where chemical contaminations of cell fractions must be avoided and can form a judgment on the growing importance of investigating the physics and chemistry of cells as *living* functions.

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Clinical Toxicology of Commercial Products. Acute poisoning (home and farm). Marion N. Gleason, Robert E. Gosselin, and Harold C. Hodge. Williams & Wilkins, Baltimore, Md., 1957. 1160 pp. $16.

This large manual is designed to guide physicians in quickly identifying and treating poisonings from commercial products. It is extremely well arranged and comprehensive. A unique frontispiece is a flow sheet of the procedure to be followed by the user and a guide to the differently colored sections to which he will turn.

The first section (white) is on emergency and first-aid treatment. Here are considered the imperative measures, necessary often within minutes, which should be carried out while more specific procedures are being arranged. The induction of vomiting or gastric lavage, for instance, is considered, from the standpoint of technique and indication.

The second section (blue) is an ingredients index of more than 1000 chemical substances. If the poison is known, this section should be consulted next in order to get a thumbnail statement about the poison and a reference to definitive treatment in the third section. The chemicals listed are primarily those commercially available and likely to be found in the home or on the farm. Drugs and natural substances are specifically omitted, although even here the authors have wisely included certain items, especially generic ones. Thus, *Amanita* and Jimson weed poisons are listed, and scopolamine and digitalis, but not synthetic and prescription drugs like the sulfonamides or chlorpromazine.

The third section (white) is the therapeutics index. This is the section in which the physician will find the specific instructions he wishes. The other sections mainly furnish different approaches to this section, the starting place depending on the type of information at hand. Thus, the second section, already mentioned, furnishes the approach when the active ingredient is known. There are 68 compounds or classes of compounds in this therapeutic section, which are prototype examples that cover the field. Thus, in section 2, under zinc one finds a reference to copper in section 3, copper being the example to serve for several metals. The therapeutic material starts with general considerations of toxicology and symptomatology, followed by clearly outlined treatment measures.

The fourth section is subsidiary to the third and describes supportive or general measures, such as the management of shock or suicidal disorientation.

The fifth section (yellow) lists, in more than 800 pages, some 15,000 trade names of poisonous or potentially poisonous products and the contained ingredients. From the critical ingredients one is led back to the second section for a reference to the specific treatment, in section 3. This progress through sections sounds complex but is, in fact, very easy, once the general system of the flow sheet is understood.

The sixth section lists general formulations, first in an index and then by general formula. Thus, if all that is known is that a suspected substance is a white tire wall cleaner, one is led to the general ingredients of tire cleaners and then to the ingredient section, as before.

Finally, there is a manufacturers' list, suggesting sources for further information.

The volume represents a vast amount of work. Certainly nothing so formidable has been prepared before in the field. Although the authors have bent every effort toward usefulness in specific accidents, the book will also have tremendous value as a reference volume. It should come to be a classic source of general toxicological knowledge for academic purposes as well as an invaluable guide to the treatment of individual patients.

Windsor Cutting
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Thermodynamics. An advanced treatment for chemists and physicists. E. A. Guggenheim. North-Holland, Amsterdam, ed. 3, 1957 (distr. by Interscience, New York). 476 pp. Illus. $9.75.

The third edition of this well-known monograph contains several important revisions, so that the chapter headings now read as follows: (i) "Introduction and fundamental principles," (ii) "Digression on statistical thermodynamics," (iii) "Some relations of general validity," (iv) "Systems of a single component," (v) "Gaseous, liquid, and solid mixtures," (vi) "Solutions, especially dilute solutions," (vii) "Systems of chemically reacting species," (viii) "Solutions of electrolytes," (ix) "Electrochemical systems," (x) "Gravitational field," (xi) "Electrostatic systems," (xii) "Magnetic systems," (xiii) "Radiation," and (xiv) "Onsager's reciprocal relations."

The principal changes relate to the chapter on mixtures and the following one, on solutions, which originally comprised several chapters. The present condensation and revision represent a marked improvement. Perhaps the most important addition is the use of excess molar functions to describe the deviation of a mixture from ideal behavior. The brief introduction, in the last chapter, to the modern theory of irreversible processes appears in this edition for the first time. To simplify matters, only isothermal systems are discussed. It is strange, therefore, that electrokinetic effects and the electric double layer are considered, whereas the important and relatively simple case of isothermal diffusion in multicomponent systems is omitted. Further changes are in the fourth chapter, where there is a new discussion of sorption, and in the ninth chapter, where the pseudothermostatic theory of galvanic cells with transference has been eliminated. The page size has been reduced, which makes for easier reading.

The text is clear, well written, and scientifically accurate. However, there are several points worth discussing in the way of criticism. (i) The consequences of the phase rule seem to be ignored in several places. For example, the Duhem-Margules equation is really an approximation, since a two-phase, two-component system has only two independent intensive variables. However, in section 5.21 it is presented as though it were exact. The following section, 5.22, on pressure dependence is not sufficient to clarify the situation. Similarly, the definition of fugacity in condensed phases (sections 4.51 and 5.19) seems to imply that a gas phase always exists in equilibrium with a condensed phase. (ii) The position that it is entirely meaningless to consider differences of electric potential between phases of different composition (section 9.03) is no longer accepted by many experts, who believe that the difficulties are experimental, not conceptual, and may be overcome eventually. Professor Guggenheim is entitled to his views, of course, but an authoritative treatise should at least mention the existence of contrary opinions, and the several dogmatic statements in chapters 8 and 9 should be replaced by more critical comments. (iii) The discussion of the third law rests largely on results of statistical mechanics which are presented without

sufficient derivation. This may disturb the reader who is not familiar with the requisite statistical theory. (iv) The theory of surfaces properly belongs in a single chapter, since experimentally it is a separate field of study and, also, since combining it with the ordinary theory of heterogeneous equilibrium tends to disrupt the continuity.

In conclusion, this monograph is better than other textbooks which cover similar material, and its weaknesses can be corrected readily by a competent instructor. *Thermodynamics* can therefore be warmly recommended as a textbook or reference work for a graduate course.

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New Books

Free Radicals in Solution. Cheves Walling. Wiley, New York; Chapman & Hall, London, 1957. 640 pp. $14.50.

Die Toxoplasmose. Bei mensch und tier. O. Thalhammer. Maudrich, Vienna, Austria, 1957 (order from Intercontinental Medical Book Corp., New York 16). 307 pp. $13.75.

Introduction to Statistical Inference. Jerome C. R. Li. Edwards, Ann Arbor, Mich., 1957. 566 pp. $7.50.

Analytical Design of Linear Feedback Controls. George C. Newton, Jr., Leonard A. Gould, James F. Kaiser. Wiley, New York, 1957. 430 pp. $12.

Chemical Phase Theory. A comprehensive treatise on the deduction, the applications and the limitations of the phase rule. J. Zernike. Kluwer's, Deventer, Netherlands. 509 pp. Fl. 70.

Engineering Manpower, How to Improve Its Productivity. A special report for management by graduate students at the Graduate School of Business Administration, Harvard University, Boston, 1957. Engineering Management Reports, P.O. Box 161, Cambridge, Mass., 1957. 162 pp. $18.50.

Handbook of Toxicology. vol. II, *Antibiotics.* William S. Spector, Ed.; compiled by John N. Porter and Gilbert C. De Mello. Saunders, Philadelphia, 1957. 276 pp.

Laboratory Guide for Elementary Plant Physiology. Rufus H. Moore. Burgess, Minneapolis, Minn., 1957. 144 pp. $3.

The Liberal Arts College. A chapter in American cultural history. George P. Schmidt. Rutgers University Press, New Brunswick, N.J., 1957. 319 pp. $6.

The Life and Work of Sigmund Freud. vol. 3, *The Last Phase, 1919–1939.* Ernst Jones. Basic Books, New York, 1957. 553 pp. $7.50.

A Modern Introduction to Philosophy. Readings from classical and contemporary sources. Paul Edwards and Arthur Pap, Eds. Free Press, Glencoe, Ill., 1957. 648 pp. $6.50.

Nuclear Chemical Engineering. Manson Benedict and Thomas H. Pigford. McGraw-Hill, New York, 1957. 608 pp. $9.50.

Pharmaceutical Calculations. Willis T. Bradley, Carroll B. Gustafson, Mitchell J. Stoklosa. Lea & Febiger, Philadelphia, ed. 3, 1957. 325 pp. $4.50.

Principles of Physical Science. Francis T. Bonner and Melba Phillips. Addison-Wesley, Reading, Mass., 1957. 752 pp. $7.50.

A Short Course in Quantitative Analysis. Hobart H. Willard, N. Howell Furman, Egbert K. Bacon. Van Nostrand, Princeton, N.J., ed. 2, 1957. 249 pp. $4.25.

Solid State Physics. Advances in Research and Application. vol. 4. Frederick Seitz and David Turnbull, Eds. Academic Press, New York, 1957. 554 pp. $12.

Steroid Homeostasis, Hypophysis and Tumorigenesis. Alexander Lipschutz. Heffer, Cambridge, England, 1957. 92 pp. 15s.

Psychopathic Personalities. Harold Palmer. Philosophical Library, New York, 1957. 179 pp. $4.75.

Systematic Organic Chemistry. Theory and applications. Hugh C. Muldoon and Martin I. Blake. McGraw-Hill, New York, 1957. 836 pp. $7.75.

A Treatise on Photo-Elasticity. E. G. Coker and L. N. G. Filon; revised by H. T. Jessop. Cambridge University Press, London, ed. 2, 1957. 755 pp. $12.50.

Annual Review of Physical Chemistry. vol. 8. H. Eyring, Ed. Annual Reviews, Palo Alto, Calif., 1957. 534 pp. $7.

The Detection and Measurement of Infra-Red Radiation. R. A. Smith, F. E. Jones, R. P. Chasmar. Clarendon Press, Oxford, England, 1957 (order from Oxford University Press, New York 11). 461 pp. $11.20.

Atoms at Your Service. Henry A. Dunlap and Hans N. Tuch. Harper, New York, 1957. 178 pp. $3.50.

An Introduction to Fluid Mechanics and Heat Transfer. With applications in chemical and mechanical process engineering. J. M. Kay. Cambridge University Press, Cambridge, England, 1957 (order from Cambridge University Press, New York 22). 325 pp. $7.

Behavior of Materials in the Earth's Crust. Papers and discussion from the second annual Symposium of Rock Mechanics. Colorado School of Mines, 21–24 April 1957. Colorado School of Mines, Golden, 1957. 306 pp. $2.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Acanthurus Randalli, a New Surgeon Fish from the Gulf of Mexico. Bulletin of the Florida State Museum, vol. 2, No. 4. John C. Briggs and David K. Caldwell. 10 pp. $0.25. *Two Pleistocene Mammalian Faunas from Alachua County, Florida.* vol. 2, No. 5. Robert S. Bader. 23 pp. $0.45. *A Taxonomic Reappraisal of the Turtle Pseudemys Alabamensis Baur.* vol. 2, No. 3. Archie Carr and John W. Crenshaw, Jr. 20 pp. $0.30. University of Florida, Gainesville, 1957.

Accidents in Childhood. Facts as a basis for prevention. Report of an advisory group. WHO Tech. Rept. Series No. 118. World Health Organization, Geneva, 1957. 40 pp. $0.30.

The Effects of the Sulfonylureas and Related Compounds in Experimental and Clinical Diabetes. Annals, vol. 71. Rachmiel Levine, Conference Chairman and Consulting Ed. New York Academy of Sciences, New York, 1957. 293 pp. $4.

Fundamentals of Combustion of Gaseous Fuels. A critical literature review. Research Bull. 15. S. A. Weil, R. T. Ellington, E. F. Searight, S. Hu. Institute of Gas Technology, Technology Center, Illinois Institute of Technology, Chicago 16, 1957. 64 pp. $5.

The Genus Fitchia (Compositae). Publs. in Botany, vol. 29, No. 1. Sherwin Carlquist. 145 pp. $2.50. *Homing Behavior of California Rocky Shore Fishes.* Publs. in Zoology, vol. 59, No. 7. George C. Williams. 36 pp. $0.75. *The Interrelationships of the New and Old World Hystricomorph Rodents.* Publs. in Zoology, vol. 56, No. 1. Stuart O. Landry, Jr. 119 pp. $2.50. University of California Press, Berkeley, 1957.

Laboratory Manual and Workbook in Anatomy and Physiology. Caroline E. Stackpole and Lutie C. Leavell. Macmillan, New York, ed. 3, 1957. 326 pp. $4.50.

Late Mogollon Communities. Four sites of the Tularosa phase, Western New Mexico. Fieldiana: Anthropology, vol. 49, No. 1. Paul S. Martin, John B. Rinaldo, Eloise R. Barter. 144 pp. $4. *Marianas Prehistory.* Archaeological survey and excavations on Saipan, Tinian, and Rota. Fieldiana: Anthropology, vol. 48. Alexander Spoehr. 187 pp. $4.50. Chicago Natural History Museum, Chicago, 1957.

Papers Presented at Engineering Test Reactor Industrial Preview, Idaho Fall, Idaho, 2–3 October 1957. In connection with design, construction, and operation of engineering test reactor, National Reactor Testing Station, Idaho, for the U.S. Atomic Energy Commission. Idaho Operations Office, U.S. Atomic Energy Commission; Phillips Petroleum Co., Atomic Energy Div.; Kaiser Engineers of H. J. Kaiser Co.; and General Electric Co., Atomic Power Equipment Dept. 12 papers.

The Pelecaniform Characters of the Skeleton of the Shoe-Bill Stork, Balaeniceps Rex. Bulletin of the British Museum (Natural History), Zoology, vol. 5, No. 3. Patricia A. Cottam. 24 pp. 8s. *A Revision of the Arhopala Group of Oriental Lycaenidae.* (Lepidoptera: Rhopalocera.) Bulletin, Entomology, vol. 5, No. 3. 57 pp. 15s. *A Revision of the Bruelia (Mallophaga) Species Infecting the Corvidae.* pt. II. Bulletin, Entomology, vol. 5, No. 4. M. Atiqur Rahman Ansari. 40 pp. 12s. *The Silver Fish and Firebrat.* Economic Leaflet, No. 3. 2 pp. 1d. British Museum (Natural History), London, 1957.

Prevention of Rheumatic Fever. Second report of the Expert Committee on Rheumatic Diseases. WHO Tech. Rept. Series No. 126. World Health Organization, Geneva, 1957. 27 pp. $0.30.

Professor Himadri Kumar Moorkerjee Memorial Volume. Proceedings of the Zoological Society, India. Zoological Society, Calcutta, 1957. 396 pp. 50s.

Meetings and Societies

Developmental Biology

Development and growth used to be studied mainly in separate compartments, as embryology, or plant physiology, or nutrition, or oncology; as seriation of stages of chick embryos; as cell division in fish eggs or plant root tips; as growth curve of children; as hormone response of plumage; as spread of a fungus; as repair of a broken bone or the swelling of a diseased spleen. Yet, in reality, all of these are merely isolated aspects of one broad, continuous spectrum of phenomena, varied manifestations of the same basic principles and elementary processes: multiplication of organic mass (growth), diversification of that mass (differentiation), pattern formation (morphogenesis), progressive change (maturation and aging), and the repair or reproduction of patterns after disturbance (regulation and regeneration).

This unity of subject matter in the field of developmental biology has received renewed emphasis in a major and highly successful undertaking, organized in 1956, known as the "Developmental Biology Conference Series 1956." It consisted of a series of coordinated and interdisciplinary conferences, symposia, and workshops, held in the United States from early June to mid-October. These were organized under the sponsorship of the Biology Council (Paul Weiss, chairman) of the Division of Biology and Agriculture, National Academy of Sciences–National Research Council, with the generous financial support of the American Cancer Society, American Cyanamid Company, Atomic Energy Commission, U.S. Departments of the Air Force, Army, and Navy (Medical Services), Diamond Alkali Company, Fulbright Fellowship Program, International Union of Biological Sciences, Merck and Company, Inc., National Institutes of Health, National Science Foundation, U.S. Office of Naval Research, Chas. Pfizer and Company, Inc., the Rockefeller Foundation, Rohm and Haas Company, E. R. Squibb and Sons, U.S. Department of State, and certain private donors.

Between 200 and 300 American experts and 54 from overseas (the latter representing 19 countries) participated, by invitation, in these events. The participants represented the fields of anatomy, biochemistry, biometry, biophysics, botany, cytology, embryology, endocrinology, genetics, histology, immunology, microbiology, neurology, nutrition, oncology, pathology, physiology, radiology, surgery, and zoology.

The following 13 coordinated meetings comprised the series: Conference of the Oak Ridge National Laboratory on Biocolloids, Oak Ridge, Tenn., 12–14 Apr.; Cold Spring Harbor Symposium on Gene Action in Relation to Development, Long Island Biological Association, New York, 4–12 June; Workshop in Developmental Biology, Bar Harbor, Me., 18–28 June; International Congress of Developmental Biology, with symposia on "Regeneration of vertebrates" and "Embryonic nutritional requirements and utilization," Brown University, Providence, R.I., 23–26 July; International Symposium on Cytodifferentiation, Brown University, Providence, R.I., 27–31 July; Work Conference on Environmental Influences on Prenatal Mammalian Development, R. B. Jackson Memorial Laboratory, Bar Harbor, Me., 2–4 Aug.; Work Conference on Immunology and Development, R. B. Jackson Memorial Laboratory, Bar Harbor, Me., 7–9 Aug.; Work Conference on Physiology of Insect Development, Growth, and Metamorphosis, Macdonald College, Ste. Anne de Bellevue, Quebec, Canada, 14–16 Aug.; Work Conference on Dynamics of Proliferating Tissues (with Emphasis on Hematopoiesis), Brookhaven National Laboratory, New York, 5–8 Sept.; Work Conference on Endocrines in Development, Shelter Island, New York, 11–13 Sept.; Work Conference on Mitogenesis, Argonne National Laboratory, Lemont, Ill., 24–26 Sept.; Work Conference on Biological Foundations of Wound Healing and Tissue Repair, Rockefeller Institute for Medical Research, New York, 2–4 Oct.; and Tissue Culture Association Decennial, Woodstock, Vt., 8–12 Oct. Of these events, 10 (all but the first two and the last in the foregoing list) were organized and administered by the Biology Council, Division of Biology and Agriculture, National Academy of Sciences–National Research Council.

Except for the International Congress of Developmental Biology, at which the participants presented formal papers, all meetings followed an informal round-table pattern of procedure. In each, anywhere from 15 to 35 investigators from various disciplines, under the programing guidance of a chairman, devoted themselves not primarily to a display of their individual research products but to a concerted review and evaluation of the bearing that the content of each specialty might have on crucial issues in the field of developmental biology. The major objectives throughout were the critical distillation of all available knowledge on a given problem, the clarification of concepts, and the resolution of incongruities and inconsistencies in the views that were current in different areas. Thus was provided the setting for a unique group exercise in which each participant contributed his share to the unification, strengthening, and elucidation of developmental biology and from which he, in turn, gained fresh orientation for his own specialized tasks.

The resultant free give-and-take of information, illustrations, questions, criticisms, and conclusions not only revealed many existing gaps in knowledge and understanding but, at the same time, furnished fresh pointers on ways to fill those gaps by specific experiment or reinterpretation. No less productive than the bringing out of constructive suggestions was the weeding out of misunderstandings that were rooted in the deficiencies of past interdisciplinary correlation. In several of the events (particularly in the Bar Harbor workshop and the Brown University series) advanced students took part as auditors and active discussants and thus benefited directly. Mature investigators were likewise impressed with the advantages of this type of conference, which significantly supplements the more common practice of holding group conferences and symposia on specialized topics of great current interest by bringing together investigators from many disciplines, in ever new combinations, for the clarification of basic issues.

On the technical side, progress toward realization of this objective resulted from the fact that many of the participants were enlisted in more than one conference—some in as many as five. In this way, their contributions could be brought to bear on a great variety of problems in different contexts, and their own views, in turn, could be enriched by exposure to new perspectives. On the practical side, this participation in several separate events by the same individuals made it possible to invite a considerably larger number of participants from abroad than would have been possible with the limited funds that were available had each made his trip in order to be present

on a single occasion. Concomitantly, this enabled them to extend their stay in the United States and to visit numerous laboratories, to the mutual advantage of the visitors and of the laboratories.

On the whole, the success of this undertaking makes it seem advisable to repeat it in other fields, for this scheme of holding a series of interrelated and coordinated conferences seems to fill a real need—that of meetings whose scope is half-way between that of the mammoth international congresses at one extreme and that of the small and independent single-purpose conferences at the other.

Plans for publishing the proceedings of the conferences in a single series are under way. These will be either in the form of third-person reports by recorders who were especially appointed to each conference or of condensed and edited transcripts of the discussion.

PAUL WEISS

Rockefeller Institute for Medical Research

Electrical Techniques in Medicine and Biology

Electrical and electronic techniques in medicine and biology will be discussed by electrical engineers, physicians, biologists, electronic instrumentologists, radiation physicists, and psychologists at the tenth annual conference on Electrical Techniques in Medicine and Biology, which will meet in Boston, Mass., 6–8 Nov. The conference is being sponsored by the American Institute of Electrical Engineers, the Instrument Society of America, and the Boston chapter of the Professional Group on Medical Electronics of the Institute of Radio Engineers.

Three morning scientific sessions and an evening panel discussion, on "Education and Research in Biophysical Engineering," are planned. The scientific sessions will include a symposium on "Problems in Sensory Perception and Replacement," and technical sessions on "Instrumentation for Circulation Research," and "Membrane Potentials and Ionic Transfer Phenomena." The registration secretary is Donald E. Williamson, Williamson Development Co., Inc., West Concord, Mass.

Soil Science in Southeast Asia

In celebration of its tenth anniversary, the Soil Science Society of the Philippines is sponsoring the first Southeast Asia Soil Science Conference in Manila, 9–22 Dec. The theme of the conference is "The Importance of Soil Science in the Agricultural Development of the Southeast Asian Countries." Problems in the management of tropical soils and means for increasing the productive capacity of these soils will be discussed. Papers will be presented in the following subjects: soil physics and mechanics; soil genesis, morphology, cartography, land classification, and soil evaluation; soil chemistry and clay mineralogy; soil extension work and agronomic education; soil fertility, fertilizer and plant nutrition; drainage and irrigation; forest and pasture land; and farm mechanization and tillage.

World Metallurgical Congress

The second World Metallurgical Congress will take place in Chicago, Ill., 2–8 Nov. under the sponsorship of the American Society for Metals. The 39th National Metals Exposition will be held simultaneously.

There will be more than 170 technical presentations. The American Society for Metals has scheduled 129 papers and discussions. Fifty of these are included in the technical program; 42 in the Atomic Energy Commission sessions on thorium, welding, and metallography; 20 in seminars on metal characteristics, and 17 in international panels presenting some 120 United States, Canadian and overseas metal scientists.

The Metals Division of the American Institute of Mining and Metallurgical Engineers will sponsor 22 symposiums, seminars, and papers. The Society for Nondestructive Testing, which will hold its second international conference in conjunction with the Metals Congress, is presenting 10 major sessions in 3 days. The Industrial Heading Equipment Association will present six technical papers; the Metal Powder Association, three papers; and the Special Libraries Association, three papers.

Trace Elements

A symposium on the Metabolic Role of Trace Elements in Plants, Animals, and Microorganisms, will be held 14–16 Oct. at Wooster, Ohio, in conjunction with the 75th anniversary celebration of the Ohio Agricultural Experiment Station.

Fourteen experts, including two from overseas, will discuss first the general role of trace minerals in plants, animals, and lower life, and then problems concerning specific elements, including manganese, selenium, cobalt, boron, iodine, molybdenum, vanadium, copper, zinc, and iron.

Andre Pirson of the Botanical Institute of the University of Marburg, West Germany, will speak on the part manganese plays in the well-being of living things, and E. J. Underwood, a member of the staff of the University of Western Australia at Nedlands, will present a general discussion of the importance of trace elements to animals.

Forthcoming Events

November

7–9. American Documentation Inst., annual, Chicago, Ill. (C. G. LaHood, Jr., Library of Congress, Washington 25.)

11–13. Radio Fall Meeting, IRE, Toronto, Ont., Canada. (V. Graham, RETMA, 11 W. 42 St., New York 26.)

11–14. American Petroleum Inst., 37th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

11–15. American Public Health Assoc., 85th annual, Cleveland, Ohio. (R. M. Atwater, APHA, 1790 Broadway, New York 19.)

11–15. American Soc. of Professional Biologists, annual, with American Public Health Assoc., Cleveland, Ohio. (A. F. Borg, Dept. of Bacteriology, Kansas State College, Manhattan.)

13–15. American Meteorological Soc., College Station, Tex. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

13–15. Clinical Chemistry Symp., Cleveland, Ohio. (F. E. Bunts Educational Inst., Cleveland, Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

13–15. Standards, 8th national conf., San Francisco, Calif. (American Standards Assoc., 70 E. 45 St., New York 17.)

13–16. Society of Naval Architects and Marine Engineers, 65th annual, New York. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

14–15. Operations Research Soc. of America, Pittsburgh, Pa. (M. L. Ernst, Box 2176, Potomac Sta., Alexandria, Va.)

14–16. American Inst. of Mining, Metallurgical, and Petroleum Engineers, semiannual, Chicago, Ill. (H. N. Appleton, AIME, 29 W. 39 St., New York 18.)

14–16. American Soc. of Refrigerating Engineers, Chicago, Ill. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

14–16. Inter-Society Cytology Council, annual scientific, Augusta, Ga. (P. F. Fletcher, 634 N. Grand Ave., St. Louis 3, Mo.)

17–22. Radiological Soc. of North America, annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse, N.Y.)

18–21. Magnetism and Magnetic Materials Conf., Washington, D.C. (L. R. Maxwell, U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md.)

18–22. American Soc. of Agronomy, annual, Atlanta, Ga. (L. G. Monthey, ASA, 2702 Monroe St., Madison, Wis.)

18–22. Citrus Virus Diseases Conf., Riverside, Calif. (J. M. Wallace, Dept. of Plant Pathology, Univ. of California, Riverside.)

18–9. Pacific Science Cong., 9th, Bangkok, Thailand. (Pacific Science Board, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

20–22. Structure of the Nucleus, chemical research conf., Houston, Tex. (W. O. Milligan, Rob't. A. Welch Foundation, P.O. Box 1892, Houston 1.)

20–24. National Assoc. for Mental Health, annual, Atlantic City, N.J. (NAMH), 10 Columbus Circle, New York 19.)

22. Tritium in Tracer Applications, symp., New York. (Symp. Committee, New England Nuclear Corp., 575 Albany St., Boston 18, Mass.)

22. Ultraviolet Scanning Microscopy Symp., Philadelphia, Pa. (H. K. Schlegelmilch, RCA Victor TV Div., Bldg. 204–2 Section 219, Cherry Hill, Camden 8, N.J.)

22–23. Tennessee Acad. of Science, 67th annual, Memphis. (W. G. Holladay, Physics Dept., Vanderbilt Univ., Nashville, Tenn.)

25–27. American Acad. for Cerebral Palsy, 11th annual, New Orleans, La. (R. R. Rembolt, Iowa Hospital–School State University of Iowa, Iowa City.)

25–27. Physics and Dynamics of Fluids, APS, Bethlehem, Pa. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

26–28. Central Assoc. of Science and Mathematics Teachers, 57th annual, Chicago, Ill. (L. Panush, Henry Ford High School, Detroit 19, Michigan.)

28–29. American Physical Soc., St. Louis, Mo. (K. K. Darrow, Columbia Univ., New York 27.)

29–30. American Soc. of Animal Production, annual, Chicago, Ill. (H. H. Stonaker, Animal Husbandry Dept., Colorado State Univ., Fort Collins.)

December

1–6. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

1–15. Bahamas Medical Conf., 4th, Nassau, Bahamas. (B. L. Frank, 1290 Pine Ave., W. Montreal, Que., Canada.)

2–5. Entomological Soc. of America, annual, Memphis, Tenn. (R. H. Nelson, ESA, 1530 P St., NW, Washington 5.)

3–4. Human Factors in Systems Engineering, symp., Philadelphia, Pa. (C. Fowler, American Electronic Labs., 121 N. 7 St., Philadelphia.)

4–8. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

4–10. American Acad. of Optometry, annual, Chicago, Ill. (C. C. Koch, 1506–1508 Foshay Tower, Minneapolis 2, Minn.)

5–7. Texas Acad. of Science, annual, Dallas. (G. C. Parker, Education Dept., Texas A&M College, College Station.)

6–7. Oklahoma Acad. of Science, annual, Enid. (J. T. Self, Dept. of Zoology, Univ. of Oklahoma, Norman.)

7–8. American Acad. of Dental Medicine, New York, N.Y. (S. Ross, 136 E. 36th St., New York 16.)

8–11. American Inst. of Chemical Engineers, annual, Chicago, Ill. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–11. Fluorides Symp., Cincinnati, Ohio. (Secretary, Inst. of Industrial Health, Kettering Laboratory, Eden and Bethesda Aves., Cincinnati 19.)

9–13. Eastern Joint Computer Conf., Washington, D.C. (H. H. Goode, Dept. of Electrical Engr., Univ. of Michigan, Ann Arbor.)

9–22. Southeast Asia Soil Science Conf., 1st, Manila, Philippines. (I. G. Valencia, Bureau of Soils, P.O. Box 1848, Manila.)

13–14. Association for Research in Nervous and Mental Disease, 37th annual, New York, N.Y. (R. J. Masselin, 700 W. 168 St., New York 32.)

17–19. Nuclear Sizes and Density Distributions Conference, Stanford, Calif. (R. Hofstadter, Stanford Univ., Stanford, Calif.)

19–21. American Physical Soc., Stanford, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

26–27. Northwest Scientific Assoc., annual, Spokane, Wash. (W. B. Merriam, Geography Dept., State College of Washington, Pullman.)

26–30. American Assoc. for the Advancement of Science, annual, Indianapolis, Ind. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

27. Association for Symbolic Logic., Cambridge, Mass. (J. Barlaz, Rutgers Univ., New Brunswick, N.J.)

(See issue of 20 September for comprehensive list)

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ PROJECTING MICROSCOPE, manufactured in Switzerland, displays image on a 7-in.-diameter ground-glass screen. Magnifications are selectable from 7 to 2000. The image may be seen through an eyepiece as well as on the ground-glass screen without making any changes in the instrument. Features and accessories include bright- and dark-field illumination by transmitted or reflected light, polarizing equipment, mechanical stages, and photographic attachments. Available models include a comparing projector for direct comparison of two specimens on the same screen. Projection onto an outside screen for classroom demonstration can also be accomplished. (Alfred Hofmann and Co., Dept. S653)

■ CAPACITANCE MEASURING DEVICE is used with the manufacturer's pressure and displacement transducers. Frequency response is ±5 percent from 0 to 15 kcy/sec. Capacitance is sensed by its effect on the resonance of a tuned circuit of which it is a component. The device is designed to plug into the Tektronix-530 and -540 series oscilloscopes. (Photocon Research Products, Dept. S656)

■ GAS PURIFIER, automatic in operation, delivers hydrogen with an oxygen content of less than 1 part per million and a dew point better than −100°F. Water is removed by two drying towers that are alternately switched into the gas stream. Oxygen is removed by catalytic reaction with hydrogen at room temperature. The equipment can be used with nitrogen, argon, helium, carbon dioxide, and saturated hydrocarbons. (Baker and Co., Inc., Dept. S658)

■ HIGH-VOLTAGE SOURCE provides an adjustable potential from 0 to 15 kv. Two voltage ranges, 0 to 1.5 kv and 0 to 15,000 kv, as well as two current ranges, 0 to 100 μa and 0 to 500 μa, are provided. Input may be 115 v a-c or 24 to 30 v d-c. Insulation resistance can be read to approximately 5000 Mohm. (Harvey-Wells Electronics, Inc., Dept. S647)

■ DUAL-PEN RECORDER is of the self-balancing potentiometer type. Chart width of 5 in. is shared by two pens. The span of each pen is adjustable between 25 and 75 percent of full chart width.

Sensitivity is 10 mv full scale when the pen spans are adjusted to one-half of chart width. Full-scale response under these conditions is 0.25 sec. Linearity is within 0.5 percent. The chart may be driven from an external shaft, a selsyn, or a synchronous motor. Change gears provide six chart speeds. Transistors and semiconductor diodes have been used instead of vacuum tubes. (Mt. Sopris Instrument Corp., Dept. S641)

■ WHEATSTONE BRIDGE has a range of 0.01 ohm to 111 Mohm with limit of error of ± (0.05 percent + 0.001 ohm) up to 100 Mohm and ± 0.5 percent above 100 Mohm. The measuring circuit is guarded against effects of static, leakage and humidity. Plug and back connections are eliminated by a single multiplier dial. (Leeds and Northrup, Dept. S595)

■ FREQUENCY DEVIATION METER provides direct read-out of deviation of frequency, in the range 1 to 10,000 cy/sec, in parts per million ± 1 count. The instrument includes a preset counter section and a display counter section. The preset counter is set to a count corresponding to the reference frequency. The preset counter is used to gate a 1-Mcy/sec signal into the display counter. Deviations of the input frequency from nominal result in deviations of the gate from 1 sec. These deviations of gate time are measured by corresponding variations in the count displayed by the 1-Mcy/sec counter. Long-term stability is 3 parts per million, per week. (Computer Measurements Corp., Dept. S630)

■ MAGNETIC-FIELD METER measures static magnetic fields with an accuracy of ± 1 percent. The most sensitive range is 1 moer full scale; the least sensitive is 1 oer full scale. Four probes are supplied. Operation is on 115-v, 60-cy/sec power. (Magnaflux Corp., Dept. S643)

■ DIGITAL RECORDER works directly from the manufacturer's counters to record counts up to five times per second. The device also acts as a digital-to-analog converter, furnishing a current or a voltage proportional to the count for input into strip-chart recorders. The analog output corresponds to any three consecutive digits of the count. Digit capacity is either 6 or 11 digits per line. Data are printed out on 3-in. roll or folded paper. (Hewlett-Packard Co., Dept. S652)

■ ZONE-MELTING APPARATUS is automatic in operation for purification of solid materials by the zone-melting technique. The apparatus holds a glass or quartz tube inside of which is placed the material to be purified. A moving table holds either induction heating coils or electric resistance heating rings which surround the tube. The table moves at a constant rate adjustable from 0.36 to 9 in./hr. Adjustable stops limit table travel and actuate a rapid-return mechanism, making multiple-pass zone-melting automatic. (Research Specialties Co., Dept. S640)

■ MAGNETIC CORE TEST JIG provides a means of applying either positive or negative current driving pulses to the core being tested. Circuits are incorporated to permit direct viewing on an oscilloscope of the current pulse at the point of application and also of the output pulse induced by switching of the core. (Burroughs Corporation, Dept. S646)

■ MASS SPECTROMETERS for the analysis of inorganic solids are offered in two models. Type M55 is designed for measurement of isotopic ratios. Excitation in this instrument is provided by the surface-ionization technique in which the sample is heated as a coating on a tungsten filament. Type M57 is designed for general analysis of solids; spark excitation is used to ionize the sample. It is a double-focusing instrument of the Mattauch type. The mass spectrum is recorded photographically. Concentrations down to 0.1 ppm can be estimated. (Metropolitan-Vickers Electrical Co., Ltd., Dept. S645)

■ SELF-BALANCING INDICATOR is available in potentiometer type for thermocouple thermometry and in a-c-bridge type for resistance thermometry. Up to 48 points for thermocouples and 36 for resistance bulbs are accommodated. Thirty scale ranges cover temperatures from −400° to +3000°F for thermocouples and −100° to +600°F for resistance thermometers. Full-scale response time is 4 sec. Accuracy is 0.25 percent of full scale. (Thermo Electric Co., Inc., Dept. S633)

■ TRANSFER-FUNCTION ANALYZER tests servo-mechanisms under conditions where the output may be nonlinear. Information necessary for the plotting of phase and gain diagrams is provided on two meter dials. Frequency range is 0.5 cy to 1 kcy/sec. (Solartron, Dept. S648)

■ DIGITAL FLOW INDICATOR gives a direct reading in gallons per minute or gallons per hour. The instrument can be adjusted to specific gravity changes to give readings in mass flow. Measurement of the ratio of two flows can also be made. (Potter Aeronautical Corp., Dept. S651)

JOSHUA STERN
National Bureau of Standards

GET YOUR ADVANCE COPY

of the General Program-Directory of the AAAS Indianapolis Meeting by first class mail – early in December

The General Program-Directory of the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

Program content

1. The two-session general symposium, "Moving Frontiers of Science II: Concepts That Mold Our Lives," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Programs of the 18 AAAS sections (symposia and contributed papers).
4. Programs of the more than 60 participating societies.
5. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, Sigma Xi-RESA.
6. Details of the Murat Temple—center of the Meeting—and of the hotels and other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1957 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1957.
2. Complete roll of AAAS presidents and their fields.
3. The 271 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

Advance Registration

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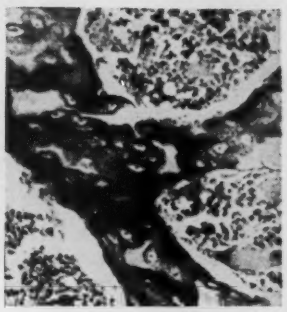

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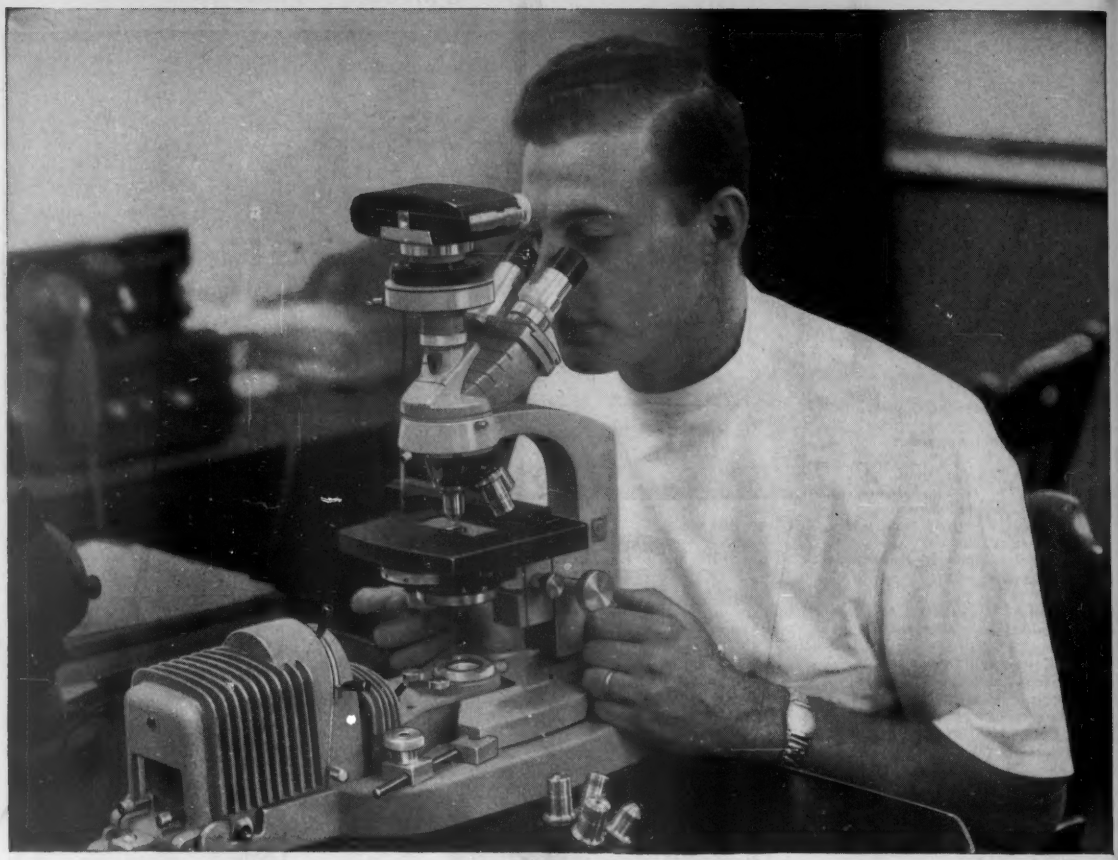

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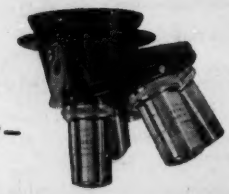

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